LIVE NATION BENTONVILLE BALLROOM

POLK STANLEY WILCOX

Bentonville, Arkansas

PROJECT MANUAL **PSW PROJECT: 1108A**

100% DESIGN DEVELOPMENT DOCUMENTS
ISSUE: JANUARY 23, 2026

ARCHITECT of RECORD
Polk Stanley Wilcox Architects

DESIGN ARCHITECT
Bjarke Ingels Group

CIVIL ENGINEER
Ecological Design Group, Inc

STRUCTURAL ENGINEER
Martin / Martin Consulting Engineers

MECHANICAL, PLUMBING & ELECTRICAL ENGINEER
Henderson Engineers

LANDSCAPE ARCHITECT
Ecological Design Group, Inc

LITTLE ROCK
FAYETTEVILLE
801 South Spring Street Little Rock, AR 72201
300 West Dickson Street Fayetteville, AR 72701
501.378.0878
479.444.0473
polkstanleywilcox.com

TABLE OF CONTENTS
FOR
LIVE NATION
BENTONVILLE BALLROOM
BENTONVILLE, ARKANSAS
PSW Project No.1108A

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

00 0900 ENGINEERING INSPECTIONS AND OBSERVATIONS
00 1002 ENDANGERED SPECIES ACT COMPLIANCE
00 1003 STORMWATER POLLUTION PREVENTION PLAN

DIVISION 01 - GENERAL REQUIREMENTS

01 1000 SUMMARY OF WORK
01 3000 SUBMITTALS AND SUBSTITUTIONS
Substitution Request Form
01 3250 PROJECT CLOSE-OUT SUBMITTALS
01 4510 SPECIAL INSPECTIONS
01 5000 TEMPORARY FACILITIES AND CONTROLS
01 5639 TEMPORARY TREE AND PLANT PROTECTION
01 5713 TEMPORARY EROSION AND SEDIMENT CONTROL
01 7000 CLEANING

DIVISION 02 - EXISTING CONDITIONS

02 4119 SELECTIVE DEMOLITION

DIVISION 03 – CONCRETE

03 3000 CAST-IN-PLACE CONCRETE
03 3500 CONCRETE FLOOR SEALER
03 4100 PRECAST STRUCTURAL CONCRETE

DIVISION 04 - MASONRY

04 2010 REINFORCED UNIT MASONRY
04 2500 THIN SET MASONRY VENEER

DIVISION 05 - METALS

05 1200 STRUCTURAL FRAMING
05 3100 STEEL DECKING
05 4000 COLD-FORMED METAL FRAMING
05 5000 MISCELLANEOUS METAL FABRICATIONS
05 5500 STEEL STAIRS AND RAILING
05 7000 DECORATIVE METAL

DIVISION 06 - WOOD, PLASTICS AND COMPOSITES

06 1000 ROUGH CARPENTRY
06 1600 GYPSUM SHEATHING
06 4000 ARCHITECTURAL WOODWORK

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 1000 WATERPROOFING
07 1010 COLD FLUID-APPLIED WATERPROOFING
07 2100 THERMAL INSULATION
07 2600 UNDER-SLAB VAPOR BARRIER
07 2610 ROOF VAPOR RETARDERS
07 2700 AIR AND WATER BARRIER
07 3011 ROOFING UNDERLAYMENT
07 4100 METAL ROOF, WALL AND SOFFIT PANELS
07 5200 MODIFIED BITUMINUS MEMBRANE ROOFING
07 6000 SHEET METAL AND FLEXIBLE FLASHING
07 7000 ROOF AND WALL SPECIALTIES AND ACCESSORIES
07 8500 FIRESTOPPING
07 9000 JOINT SEALANTS

DIVISION 08 - OPENINGS

08 0350 EXTERIOR ENCLOSURE - GENERAL
08 0355 EXTERIOR ENCLOSURE MOCK-UP and TESTING
08 1000 HOLLOW METAL DOORS AND FRAMES
08 3500 OVERHEAD COILING DOORS
08 4000 ENTRANCES AND STOREFRONTS
08 4050 GLAZED CURTAIN WALLS
08 5115 ALUMINUM WINDOWS
08 7000 HARDWARE
08 8000 GLAZING

DIVISION 09 - FINISHES

09 2500 GYPSUM DRYWALL
09 2700 DRYWALL SHAFT SYSTEMS
09 3100 TILE
09 5100 ACOUSTICAL CEILINGS
09 6510 RUBBER BASE
09 6750 SEAMLESS EPOXY FLOORING
09 7200 WALL COVERING
09 8316 SPRAY-APPLIED ACOUSTICAL INSULATION
09 8400 ACOUSTICAL WALL PANELS
09 9000 PAINTING

DIVISION 10 - SPECIALTIES

10 1500 TOILET PARTITIONS
10 5200 FIRE PROTECTION SPECIALTIES
10 8000 TOILET AND BATH ACCESSORIES
10 9500 MISCELLANEOUS SPECIALTIES

DIVISION 11 - EQUIPMENT

11 1600 LOADING DOCK EQUIPMENT

DIVISION 12 - FURNISHINGS

12 5200 MECHANICAL WINDOW SHADES AND CURTAINS

DIVISION 13 - SPECIAL CONSTRUCTION

DIVISION 14 - CONVEYING EQUIPMENT SYSTEMS

14 2400 HYDRAULIC PASSENGER ELEVATORS

DIVISION 21 - FIRE SUPPRESSION

21 0010 GENERAL FIRE SUPPRESSION REQUIREMENTS
21 0500 COMMON WORK RESULTS FOR FIRE SUPPRESSION
21 0515 BASIC FIRE SUPPRESSION PIPING MATERIALS AND METHODS
21 0553 IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT
21 1100 FIRE SUPPRESSION WATER SERVICE PIPING
21 1313 WATER BASED FIRE SUPPRESSION SYSTEMS

DIVISION 22 - PLUMBING

22 0010 GENERAL PLUMBING REQUIREMENTS
22 0015 COORDINATION
22 0500 COMMON WORK RESULTS FOR PLUMBING
22 0513 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
22 0515 BASIC PIPING MATERIALS AND METHODS
22 0519 METERS AND GAUGES FOR PLUMBING PIPING
22 0523 GENERAL-DUTY VALVES FOR PLUMBING PIPING
22 0529 HANGERS AND SUPPORTS FOR PLUMBING PIPING
22 0553 IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT
22 0700 PLUMBING INSULATION
22 1100 WATER DISTRIBUTION PIPING & SPECIALTIES
22 1111 MECHANICALLY JOINED PLUMBING PIPING SYSTEMS
22 1113 FACILITY WATER DISTRIBUTION PIPING
22 1123 DOMESTIC WATER PUMPS
22 1300 SANITARY DRAINAGE & VENT PIPING & SPECIALTIES
22 1313 FACILITY SANITARY SEWERS
22 1400 STORM DRAINAGE PIPING & SPECIALTIES
22 1489 SUMP PUMPS
22 3300 ELECTRIC DOMESTIC WATER HEATERS

22 4000 PLUMBING FIXTURES
22 7000 NATURAL GAS SYSTEMS
22 7010 MECHANICALLY JOINED NATURAL GAS PIPING SYSTEMS

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

23 0010 GENERAL MECHANICAL REQUIREMENTS
23 0015 ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT
23 0500 COMMON WORK RESULTS FOR HVAC
23 0510 BASIC PIPING MATERIALS AND METHODS
23 0513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
23 0514 VARIABLE FREQUENCY DRIVES
23 0529 HANGERS AND SUPPORTS FOR HVAC
23 0550 VIBRATION ISOLATION FOR HVAC
23 0553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 0593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
23 0700 HVAC INSULATION
23 0800 COMMISSIONING OF HVAC SYSTEMS
23 0913 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
23 0923 DIRECT-DIGITAL CONTROL FOR HVAC
23 1213 FACILITY FUEL-OIL PUMPS
23 1313 FACILITY UNDERGROUND FUEL OIL STORAGE TANKS
23 1323 FACILITY ABOVEGROUND FUEL OIL STORAGE TANKS
23 2113 HYDRONIC PIPING
23 2113.13 UNDERGROUND HYDRONIC AND STEAM PIPING
23 2113.23 MECHANICALLY-JOINED HYDRONIC PIPING SYSTEMS
23 2113.43 POLYPROPYLENE HYDRONIC PIPING
23 2115 GROUND LOOP HEAT PUMP PIPING
23 2116 HYDRONIC SPECIALTIES
23 2123 HYDRONIC PUMPS
21 2300 REFRIGERANT PIPING
21 2313 VRF REFRIGERANT PIPING
23 3113 METAL DUCTS
23 3300 AIR DUCT ACCESSORIES
23 3413 AXIAL HVAC FANS
23 3416 CENTRIFUGAL HVAC FANS
23 3600 AIR TERMINAL UNITS
23 3713 DIFFUSERS, REGISTERS AND GRILLES
23 3815 GREASE SCRUBBERS
23 5113 DRAFT CONTROL DEVICES
23 8127 VARIABLE REFRIGERANT FLOW (VRF) SPLIT AC SYSTEMS
23 8149 ROOFTOP HEAT PUMP UNITS
23 8413.23 DIRECT STEAM INJECTION HUMIDIFIERS
23 8500 ELECTRIC HEATING UNITS

DIVISION 26 - ELECTRICAL

26 0010 GENERAL ELECTRICAL REQUIREMENTS
26 0500 COMMON WORK RESULTS FOR ELECTRICAL
26 0502 EQUIPMENT WIRING SYSTEMS
26 0504 PROVISIONS FOR ELECTRICAL UTILITY SERVICE
26 0519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 0526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 0529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
26 0533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
26 0536 CABLE TRAYS FOR ELECTRICAL SYSTEMS
26 0543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
26 0553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
26 0573 POWER SYSTEM STUDIES
26 0923 LIGHTING CONTROL DEVICES
26 2200 LOW-VOLTAGE TRANSFORMERS
26 2413 SWITCHBOARDS
26 2416 PANELBOARDS
26 2726 WIRING DEVICES
26 2813 FUSES
26 2816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
26 3353 STATIC UNINTERRUPTIBLE POWER SUPPLIES
26 3600 TRANSFER SWITCHES
26 3633 CONNECTION CABINETS FOR PORTABLE GENERATORS AND LOAD BANKS
26 4113 LIGHTNING PROTECTION FOR STRUCTURES
26 4313 SURGE PROTECTIVE DEVICES
26 5100 INTERIOR LIGHTING

DIVISION 27 - COMMUNICATIONS

27 0500 COMMON WORK RESULTS FOR COMMUNICATIONS
270529 PATHWAYS FOR AV SYSTEMS
27 0543 UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS
27 1323 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING
27 5319.20 EMERGENCY RESPONDER RADIO COVERAGE SYSTEM (ERRCS)

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 0010 GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS
28 0510 COMMON WORK RESULTS FOR ELECTRONIC SECURITY
28 1000 ELECTRONIC SECURITY SYSTEMS
28 1010 CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY
28 1015 TELECOMMUNICATIONS REQUIREMENTS FOR ELECTRONIC SECURITY
28 1020 EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY
28 1300 ACCESS CONTROL
28 1523 INTERCOM ENTRY SYSTEMS
28 3100 INTRUSION DETECTION
28 3111 DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEMS

DIVISION 31 - EARTHWORK

31 1000 SITE CLEARING
31 2000 EARTH MOVING
31 2116 TRENCHING
31 3110 TERMITE CONTROL
31 5000 EXCAVATION SUPPORT AND PROTECTION

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 0523 CONCRETE FOR EXTERIOR IMPROVEMENTS
32 1216 ASPHALT PAVING
32 1313 CONCRETE PAVING
32 1373 CONCRETE PAVING JOINT SEALANTS
32 3100 ORNAMENTAL FENCES AND GATES
32 9113 SOIL PREPARATION
32 9200 TURF AND GRASSES
32 9300 PLANTS

DIVISION 33 - UTILITIES

33 0500 COMMON WORK RESULTS FOR UTILITIES
33 0513 MANHOLE AND STRUCTURES
33 1000 SITE WATER DISTRIBUTION
33 1100 WATER SERVICE CONNECTIONS
33 1200 DISINFECTION OF WATER DISTRIBUTION
33 4111 STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Engage and provide a qualified Engineering Inspections and Observations firm to provide Owner and Engineer of Record daily Inspections and Observations and reports in addition to other inspections and observations required in other Specification Sections for the project. Frequency of Inspections and Observations shall be on an as-needed basis.
   1. At a minimum the Inspections and Observations Engineer shall witness materials sampling and testing, City Inspections requiring an Owner Representative, and monthly Progress meetings.
   2. Engineer of record may be retained at their standard hourly billing rate.
   3. A third-party Engineer licensed in the State of Arkansas may be retained to provide the required daily Inspections and Observations.

B. Inspections and Observations Engineer shall report directly to the project Engineer of Record and the Owner.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall comply with all requirements and recommendations of the United States Endangered Species Act and Gold and Bald Eagle Protection Act. All construction activity shall comply with the recommendations and requirements of the US Fish and Wildlife Service for the protection of endangered species. The following documents and codes are hereby incorporated by reference to these Project Specifications.
   1. Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.)
   2. Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

B. There are NOT known endangered species, or Bald or Golden Eagles present at or near the proposed work areas.

C. If endangered species or Bald or Golden Eagles are encountered during construction the Contractor shall stop work immediately and notify the Owner and Engineer. Contractor shall await direction prior to commencing work activities.

D. Contractor shall conduct a tree removal pre-construction conference to review the trees to be removed.

E. Contractor shall obtain written approval form the City, Owner, and Engineer prior to any burning of trees or brush onsite.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall comply with all requirements and recommendations of the Arkansas Department of Environmental Quality (ADEQ) Construction Stormwater Discharge Permit. The following documents and codes are hereby incorporated by reference to these Project Specifications.
   1. Stormwater Pollution Prevention Plan (SWPPP) for Construction Activities for Small Construction Sites.
   2. ADEQ SWPPP General Permit No. ARR150000.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1 - GENERAL

1.01 WORK UNDER THIS CONTRACT

A. Bentonville Live Nation Concert Venue is a proposed 46,123 square foot ground up concert and performance facility located at the intersection of SE E St. And SE 8th St. at the edge of the Momentary Cultural Campus in Bentonville, Arkansas. The total Project site area is 1.38 acres (59,335 SF), to be confirmed by the client and owner. The proposed mixed-use assembly building will be 2 stories, reaching 60'-0" in height. The building will house 1 concert/performance platform with support and hospitality programs including: public lobby, management offices, dressing rooms, green rooms, patron dining and beverage experience, plus loading and back of house facilities.

1.02 RESPONSIBILITIES OF CONTRACTOR

A. Except as otherwise specifically stated in the contract, Contractor shall provide and pay for all materials, labor, tools, equipment, water, light, heat, power, transportation, superintendence, temporary construction of every nature, taxes legally collectible because of the Work and all other services and facilities of any nature necessary to execute Work as shown and/or specified under the contract and deliver it complete in every respect within specified time.

B. If, during the course of construction of this project, the Contractor discovers errors, inconsistencies or omissions in the Contract Documents, the Contractor will report them to the Architect who will issue written instructions to the Contractor. If the Contractor performs Work knowing there is an error, inconsistency or omission in the Contract Documents without giving notice to the Architect or receiving written instruction from the Architect, the Contractor assumes responsibility for the Work and will bear all costs associated with the performance or correction of the Work.

1.03 PERMITS

A. Utilizing the contract documents (Project Manual and Drawings) prepared by the Architect and his Consultants, along with information provided by the Owner or his Consultants, the Contractor is responsible for securing permits required to successfully complete the project. This responsibility includes payment for the permit and coordination of all submittals.

B. Storm Water Discharge Permit: Contractor shall be responsible for obtaining this permit from Arkansas Department of Environmental Quality for construction sites where one (1) acre or more is disturbed, and meet all other storm water regulations. Contractor shall keep a copy of his Storm Water Discharge Permit on the jobsite at all times.

1.04 COORDINATION

A. Provide administrative and supervisory requirements necessary for coordination of work, including meetings, administrative and supervisory personnel, survey, records, reports, limitations for use of site, installation provisions, cutting and patching, cleaning, protection, and conservation.

B. Coordinate construction activities included under various sections of these specifications to assure efficient and orderly installation of each part of the work. Coordinate construction operations included under different sections of the specifications that are dependent upon each other for proper installation, connection, and operation.
   1. Where installation of one part of the work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain its best results.
   2. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

C. Where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

D. Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of schedules
   2. Installation and removal of temporary facilities
   3. Delivery and processing of submittals
   4. Progress meetings
   5. Project close-out activities

E. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water and materials.

1.05 PROJECT MEETINGS

A. Pre-Construction Meeting: Within 15 days after execution of agreement, the Architect will prepare an agenda and schedule a pre-construction meeting. Written notice of meeting date, time and place, and agenda items will be sent to the Owner, Contractor, and Separate Contractors. The Contractor shall be responsible for notifying major subcontractors of meeting.

B. Progress Meetings: The Contractor shall schedule and hold regular progress meetings to coordinate, expedite and schedule work of all contracts. Hold additional meetings as progress of work dictates or when requested by the Architect. Send written notice of meeting date, time and place, and agenda of meeting to the Owner, Architect/Engineer, Separate Contractors, Subcontractors and others as pertinent to agenda. Record results of meetings and distribute copies to everyone in attendance and to others affected by the decisions or actions resulting from each meeting.

C. Additional meetings listed below may be required by the Architect to ensure coordination between all parties and construction documents. Contractor is to prepare agendas and provide to the Architect and other parties at least 3 days prior to the meeting for review. Meeting is to include the Architect, Engineer(s), Contractor, sub-contractor(s), and Owner.

1. On site soils placement and compaction below building footprint, initially, and beneath paved areas, secondary.
2. Compaction around and placement of site drainage and utility structures.
3. Construction of site retaining walls (if applicable).
4. Compaction of and placement of concrete in footing trenches.
5. Placement and detailing of below-grade or horizontal waterproofing (if applicable).
6. Placement of below slab vapor barriers
7. Placement of slab on grade and protection during curing, including visits during concrete placement and curing processes.
8. Erection of structural steel framing or load bearing assemblies.
9. Installation of exterior building skin, anticipated detailing and placement of flashings and sealants, with special attention at expansion locations, difficult conditions or material transitions.
10. Installation of curtain walls, storefronts, and windows, anticipated detailing and placement of sills, flashings and sealants.
11. Installation of roofing membranes, flashings and sheet metal.

1.06 CONTRACTOR USE OF PREMISES

A. Confine operations at site to areas permitted under Contract. Portions of site beyond areas on which work is indicated are not to be disturbed.

B. Limit use of premises to work indicated, allowing for Owner occupancy and public use.

1. Keep existing driveways and entrances serving premises clear and available to Owner, employees, and public at all times. Do not use these areas for parking or storage of materials.
2. Do not unreasonably encumber site with materials or equipment.
3. Lock automotive type vehicles, such a passenger cars and trucks and other mechanized or motorized construction equipment, when parked and unattended, to prevent unauthorized use. Do not leave vehicles or equipment unattended with motor running or ignition key in place.
4. Open fires will not be permitted on premises.

1.07 INDUSTRY STANDARDS

A. Applicability of Standards: Except where more explicit or stringent requirements are written into the contract documents, applicable construction industry standards have the same force and effect as if bound into or copied directly into the contract documents. Such industry standards are made a part of the contract documents by reference. Individual specification sections indicate which codes and standards the Contractors must keep available at project site for reference.

B. Publication Dates: Except as otherwise indicated, where compliance with an industry standard is required, comply with standard in effect as of date of contract documents.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and where these standards establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the contract documents specifically indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Architect for a decision before proceeding.

D. Copies of Standards: The Contract Documents require that each entity performing work be experienced in that part of the work being performed. Each entity is also required to be familiar with industry standards applicable to that part of the work. Copies of applicable standards are not bound with the contract documents. Where copies of standards are needed for proper performance of the work, the Contractors are required to obtain such copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where acronyms or abbreviations are used in the specifications or other contract documents they are defined to mean the recognized name of the trade association, standards generating organization, governing authority, or other entity applicable to the context of the text provisions.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Make submittals required by Contract Documents; revise and resubmit as necessary to establish compliance with specified requirements. Submittals which are received from sources other than through the General Contractor's office will be returned by the Architect without action.

B. Submit documents in the following formats:
   1. Color selection requires actual materials or color cards. Reproductions and electronic copies will not be accepted.
   2. Electronic submittals of product and material data and shop drawings are preferred unless specifically requested to be hard copy by Architect.

1.02 ELECTRONIC SUBMITTAL PROCEDURES

A. Summary
   1. Shop drawing and product data submittals shall be transmitted to Architect in electronic (PDF) format.
   2. The electronic submittal process is not intended for color samples, color charts, or physical material samples.

B. Procedures
   1. Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work.
   2. Contractor shall transmit each submittal to Architect.
   3. Architect / Engineer review comments will be made available.
   4. Distribution of reviewed submittals to subcontractors and suppliers is the responsibility of the Contractor.
   5. Submit electronic copies of reviewed submittals at project closeout for record purposes in accordance with Section 01 3250 – Closeout Submittals

C. Contractor's submittal of (and Architect's review of) shop drawings, product data or samples which relate to work not complying with requirements of Contract Documents, does not constitute an acceptable or valid request for a substitution, nor approval thereof.

1.03 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section.

1.04 QUALITY ASSURANCE

A. Coordination of Submittals: Prior to each submittal, carefully review and coordinate all aspects of each item being submitted. By affixing Contractor's approval stamp to each submittal, certify that coordination has been performed.

B. Verify that each item and submittal for it conforms in all respects with specified requirements.

1.05 TIMING OF SUBMITTALS

A. General: Make submittals far enough in advance of scheduled dates of installation to provide required time for reviews, securing necessary approvals, possible revision and resubmittal, placing orders and securing delivery.

B. Owner will not bear costs of delays due to late submittals.

1.06 COORDINATION AND SEQUENCING

A. Coordinate preparation and processing of submittals with performance of work so that work will not be delayed by submittals.

B. Coordinate and sequence different categories of submittals for same work, and for interfacing units of work, so that one will not be delayed for coordination of Architect's review with another.

PART 2 - PRODUCTS

2.01 PROGRESS SCHEDULE

A. Within 7 days after Notice to Proceed, submit to Architect a bar-chart type progress schedule indicating time bar for each trade or operation of work to be performed. Time bar shall demonstrate planned work, properly sequenced and intermeshed, for expeditious completion of Work. Identify phases if required.

B. Distribute progress schedule including all updates to Architect, Owner, subcontractor, suppliers, fabricators, and others with need-to-know schedule compliance requirements. Post copy in field office.

2.02 SCHEDULE OF VALUES

A. Immediately after execution of the Contract Documents, Contractor shall submit for approval a Schedule of Values totaling the amount of the Contract.

B. Schedule of Values line items are to be numbered and ordered in accordance with CSI Master Format numbering system. Refer to the Table of Contents in this Project Manual for correct numbering.

2.03 SCHEDULE OF SUBMITTALS

A. In accordance with General Conditions Document AIA A201, within 30 calendar days after execution of the Contract Documents, Contractor shall submit a Schedule of Submittals to the Architect. Note any critical submittals and long lead items that need to be expedited.
   1. Unless otherwise agreed between Contractor and Architect, the Architect will have 10 working days for initial review of submittals.

2.04 LIST OF SUBCONTRACTORS

A. Immediately after execution of the Contract Documents, Contractor shall submit for approval a listing of all subcontractors to be used for the project stating portions of Work to be performed, address and telephone number of firm, and contact at firm familiar with project.

B. If all subcontrators have not been determined, submit a partial listing with regular updates indicating newly added subcontractors.

2.05 SUBSTITUTION REQUESTS

A. Products specified herein establish a quality standard for comparison by manufacturers of similar products. Products of other manufacturers may be substituted for those specified herein on an "Approved Equal" basis. DO NOT propose the substitution of products that do not meet or exceed the quality standards established by the specified product. Products proposed as equivalent MUST be submitted through the General Contractor for review by the Architect after the Contract for Construction is awarded. DO NOT request approval of products prior to the awarding of the contract.

B. Requests for substitution will be reviewed when extensive revisions to contract documents are not required and changes are in keeping with general intent of Contract Documents; when timely, fully documented and properly submitted; and when one or more of following conditions is satisfied, all as judged by Architect/Engineer. Otherwise, requests will be returned without action except to record non-compliance with these requirements.
   1. Where request is directly related to an "or equal" clause or other language of same effect in Contract Documents.
   2. Where required product, material or method cannot be provided within Contract Time, but not as a result of Contractor's failure to pursue the Work promptly or to coordinate various activities properly.
   3. Where required product, material or method cannot be provided in a manner which is compatible with other materials of the Work, or cannot be properly coordinated therewith, or cannot be warranted as required, or cannot be used without adversely affecting Owner's insurance coverage on completed work, or will encounter other substantial non-compliances which are not possible to otherwise overcome except by making requested substitution, which Contractor thereby certified to overcome such non-compatibility, non-coordination, non-warranty, non-insurability or other non-compliance as claimed.

4. Where required product, material or method cannot receive required approval by a governing authority, and requested substitution can be so approved.
5. Where substantial advantage is offered Owner, in terms of cost, time, energy conservation or other valuable considerations, after deducting offsetting responsibilities Owner may be required to bear increased cost of other work by Owner or separate contractors, and similar considerations.

C. **SUBSTITUTIONS REQUESTS MUST BE SUBMITTED WITHI 30 DAYS AFTER THE DATE OF THE NOTICE TO PROCEED**. Substitution requests received after that time will be returned and the Contractor will be required to provide the product specified, except as follows:
1. Unavailability of product, material or method, not due to the Contractor's failure to pursue the work promptly or to coordinate various activities properly.

D. Submit request for substitutions in writing using the Substitution Request form found at the end of this Section. This is the only form that will be accepted.

E. Submit substitution request, fully identified for product or method being replaced by substitution, including related specification section and drawing number(s), and fully documented to show compliance with requirements for substitutions. Include manufacturer's product data/drawings, description of installation methods, material samples where applicable, complete color and finish selection cards or samples, Contractor's detailed comparison of significant qualities between specified item and proposed substitution, statement of effect on construction time and coordination with other affected work, cost information or proposal, and Contractor's statement to the effect that proposed substitutions will result in overall work equal-to-or-better-than work originally indicated.

F. Failure to provide the requested data and samples within the specified time frame will be grounds for rejection as a comparable product.

G. Do not incorporate substitutions into Shop Drawings until they have been reviewed by the Architect and written permission has been issued to make the proposed substitution a part of the contract.

H. Under no circumstances shall Architect's review of any such substitution relieve Contractor from timely, full and proper performance of Work.

I. In the event that the substitution of a product by the General Contractor necessitates the redrawing, redesign, modification or other change to the Contract Documents, the General Contractor will bear all associated costs of these changes.

2.06 REQUEST FOR SUPPLEMENTARY INFORMATION

A. Make timely requests of Architect for additional information required in planning and production of Work.

B. File requests in ample time to permit appropriate action by all parties involved and avoid delay in performance of Work.

C. Owner will not bear costs for delays due to Contractor's failure to request information in a timely manner.

2.07 SHOP DRAWINGS

A. Provide newly-prepared information with graphic information at accurate scale (except as otherwise indicated), with name of preparer indicated (firm name). Do not duplicate and submit Architect's construction drawings as shop drawings. Show dimensions and notes which are based on field measurement. Identify materials and products in work shown. Indicate compliance with standards, and special coordination requirements.

1. Contract Document electronic files (including all drawings, specifications, addenda and supplemental information) will not be made available to Bidders or Sub-bidders before the award of a Contract. After the award of the Contract, the General Contractor may make request for release of electronic document files.

B. Shop drawings must bear Contractor's approval stamp. This approval stamp certifies that the Contractor has reviewed the shop drawings, product data, samples or similar submittals for conformance with the Contract Documents. All deviations will be noted in writing and highlighted on the submittal for Architect's review. The Architect is not responsible for errors, omissions or deviations in the shop drawings, product data, samples or similar submittals by the Contractor.

C. Submittals are reviewed by the Architect for design intent only. The Contractor is responsible for verification of dimensional requirements, compliance with contract documents and local codes, quantities and coordination of all affected trades.

D. Under no circumstances shall Architect's review of shop drawings or submittals relieve Contractor from timely, full and proper performance of Work in accordance with the Contract Documents.

2.08 PRODUCT DATA

A. Collect required data into one submittal for each unit of work or system; mark each copy to show which choices and options are applicable to project AND WHICH ARE AVAILABLE FOR SELECTION BY THE ARCHITECT WITHOUT ADDITIONAL COST. NO PAYMENT WILL BE MADE FOR ADDITIONAL COST OF ANY CHOICES OR OPTIONS SUBMITTED BY THE CONTRACTOR FOR SELECTION BY THE ARCHITECT AND NOT CLEARLY SHOWN AS NOT AVAILABLE WITHIN THE CONTRACT.

B. Include manufacturer's standard printed recommendations for application and use, compliance with standards, application of labels and seals, notation of field measurements which have been checked, and special coordination requirements.

C. Maintain one set of product data (for each submittal) at project site, available for reference by Architect and others.

D. Do not submit product data until compliance with requirements of contract documents has been confirmed by Contractor.

E. Installer's Copy: Do not proceed with installation of materials, products or systems until final copy of applicable product data is in possession of installer.

2.09 SAMPLES

A. Submit accurate color and pattern charts or actual material samples to Architect for selection. Refer to pertinent sections of specifications for detailed submittal requirements. Provide units identical with final condition of proposed materials or products for the work. Include "range" samples (not less than 3 units) where unavoidable variations must be expected, and describe or identify variations between units of each set.

B. Make all submissions affecting color selection within sufficient time to allow selection without causing delay in Work.

C. Submit items requiring color selection or verification as one submittal to facilitate coordination of all colors at one time. Interior items may be submitted separately from exterior items.

D. Provide full set of optional samples where Architect's selection is required. DO NOT INCLUDE OPTIONS REQUIRING ADDITIONAL COST.

E. Samples are submitted for review and confirmation of color, pattern, texture and "kind" by Architect. Architect will not "test" samples (except as otherwise indicated) for compliance with other requirements, which are therefore the exclusive responsibility of Contractor.

F. Submit 3 sets of samples in final submittal.
   1. Furnish two sets to Architect and assemble one set on site. When all samples are on site, Owner and Architect are to review. Contractor shall provide job samples indicating finished color selections for any and all items requiring finish color for project.
   2. Quality Control Set: Maintain returned final set of samples at project site, in suitable condition and available for quality control comparisons by Architect and Owner. Written approval from Owner is required before the work is begun for any finish requiring color review.

G. Reusable Samples: Returned samples which are intended or permitted to be incorporated into Work must be in undamaged condition at time of use.

2.10 STRUCTURAL SUBMITTALS

A. Structural submittals include shop drawings, design calculations, diagrams, illustrations, schedules, performance charts, nomenclature charts, samples, brochures and other data prepared by the Contractor or any subcontractor, manufacturer, supplier, fabricator, or distributor and which illustrate some portion of the Project directly related to the structural design of the project.

B. Contractor shall make all submittals in advance of installation or construction to allow sufficient time for review.

C. Work requiring shop drawings, whether called for by the Contract Documents or requested by the Contractor, shall not commence until the submission has been reviewed by the Architect/Structural Engineer. Work may commence if the Contractor verifies the accuracy of the Architect/Structural Engineer's corrections and notations and complies with them without exception and without requesting change in Contract Sum or Contract Time.

PART 3 - EXECUTION

3.01 SUBMITTAL PREPARATION

A. Permanently mark each submittal to identify project, date, Contractor, subcontractor, submittal name and similar information to distinguish it from other submittals. Show Contractor's executed review and approval marking.

B. Indicate project, date, "To:"; "From:"; names of subcontractors, suppliers, manufacturers, required references, category and type of submittal, purpose, description, distribution record and signature of transmitter.

C. Indicate drawing number and specifications section number to which submittal applies.

3.02 ARCHITECTS ACTION ON SUBMITTALS

A. Architect's Submittal Review: Submittal review does not relieve Contractor(s) of compliance with Contract Documents or local codes. Review is only for conformance with the design intent of the Project and compliance with information given in the Contract Documents. The contractor is responsible to coordinate and to confirm all dimensions for use at the site. The contractor is responsible for coordination of the work of all trades.

B. Architect's Action: Where action and return is required or requested, Architect will review each submittal and mark per the following, and where possible return within ten (10) working days of receipt. When a submittal must be coordinated with submittals of other trades, Contractor is responsible for gathering all information and forwarding to Architect as a single submittal.

C. Architect's Response:

1. Final Unrestricted Release: Work may proceed, when submittal is returned with the following: **Marking: "Reviewed".**
2. Final-But-Restricted Release: Work may proceed, provided it complies with notations and corrections on submittal and with Contract Documents, when submittal is returned with the following: **Marking: "Furnish as Corrected".**
3. Returned for Resubmittal: Do not proceed with work. Revise submittal in accordance with notations, and resubmit without delay to obtain a different action marking. Do not allow submittals with the following marking (or unmarked submittals where a marking is required) to be used in connection with performance of the Work: **Marking: "Revise & Resubmit".**
4. Other Actions: Where submittal is returned **"Rejected"** or **"Submit Specific Item"**, an explanation will be provided.

END OF SECTION

POLK STANLEY WILCOX ARCHITECTS
300 West Dickson Street
Fayetteville, Arkansas 72701

SUBSTITUTION REQUEST

Project: Live Nation Bentonville Ballroom
Project No: 1108A
Date:
Contractor:
Contact Person:

Contractor hereby requests consideration of a product substitution as follows:

1. Refer To: Section - _____ and/or Drawing - _____
2. Item Description: _____
3. Proposed Substitution:
   Manufacturer: _____
   Model Number: _____
   Description: _____
4. Reason for Substitution:
   ____ Availability
   ____ Delivery Schedule
   ____ Cost Advantage
   ____ Quality Advantage
   ____ Performance Advantage
   ____ Other: _____
5. Coordination:
   Difference in dimensions between the specified and proposed substitute **(WILL) (WILL NOT)** affect dimensions on drawings and adjacent items.

   Describe the effect of the substitution on work of other trades: _____

   Describe the effect of the substitution on other required new or existing materials including electrical wiring, piping, ductwork, finishes, structure, etc.: _____

   Acceptance of this substitution will cause **(NO CHANGE IN) (A REDUCTION OF_____ DAYS FROM)** the completion date of this project.

   Describe any required architectural or engineering design changes required to accommodate the substitution: _____
6. Differences:
   The proposed substitution **(MEETS) (DOES NOT MEET)** the reference standards (ASTM, AWI, UL, etc.) as specified.

   The proposed substitution **(MEETS) (DOES NOT MEET)** the fire rating classification (class, type, FM, UL, NFPA) as specified.

   The proposed substitution is available in the following **(COMPARABLE) (LIMITED) (ADDITIONAL)** finishes.

   Note: Any additional cost associated with proposed substitute finishes will be absorbed by the contractor if this substitution is approved and implemented.

7. Warranty:
   Specified Warranty Length and Coverage:_____
   Substitute Warranty Length and Coverage (Sample warranty attached):_____
   _____
8. This substitution will result in a cost savings and credit of $_____.
9. The proposed substitute has been used in the following installations (attached):_____
   _____
10. Service and replacement material are available from the following (attached):_____
    _____

By submitting this Request for Substitution, the Contractor accepts the following terms and conditions:

1. The proposed substitution, if accepted, will provide performance equivalent to the material or equipment specified. Should a substitution be accepted and should the substitute material or equipment prove defective or otherwise unsatisfactory for the service intended, the Contractor will replace the material or equipment with the material or equipment specified.
2. If the substitution will affect a correlated function, adjacent construction, or work of other trades or contractors, the necessary changes and modifications to affected work are considered to be part of the substitution and will be accomplished without additional cost to the Owner.
3. In the event that the substitution of materials or equipment necessitates the redrawing, redesign, modification or other change to the Contract Documents, the General Contractor will bear all associated costs of these changes.

Contractor warrants that they have verified and believe this substitute is equal or superior to the specified item in all respects. There will be no additional cost associated with coordinating installation of this substitute. Costs and effects of the substitution, as outlined herein, are certified and complete. Claims for additional costs related to acceptance of this substitution, which may become apparent later, are waived.

Manufacturer's product cut sheets, drawings, samples, data sheets, sample warranties, manufacturer's certification, etc. for the substitute are attached.

Contractor:_____ Date:_____

By:_____

Typed Name:_____

Architect's Action:

Substitution is Accepted:_____

Substitution is Rejected for the following reason(s):_____
_____

By:_____

Typed Name:_____

Date:_____

PART 1 - GENERAL

2.01 CLOSEOUT SUBMITTALS

A. Upon completion of Work and **prior to final payment**, **electronic copies** of the following items must be submitted to Architect:
   1. General Contractors letter of warranty
   2. General Contractors letter stating that all deficiency list items are complete
   3. Lien releases
   4. Consent of Surety to pay final retainage
   5. List of all subcontractors and suppliers, including portions of the work performed, address and telephone number of firm, and a contact name familiar with the project.
   6. Guarantees and Warranties: Two fully executed copies of each guarantee and warranty specified. Note that all guarantees and warranties begin at the date of substantial completion.
   7. Certificates: Fully executed copy of each certificate specified.
      a. Certificate of Occupancy
      b. Final Termite Inspection
      c. Final Plumbing Inspection
      d. Final Electrical Inspection
      e. Certificate of Air Balance
   8. Miscellaneous other inspection reports:
      a. Elevators and Hoist Systems
      b. Backflow Preventers on Potable Water
      c. Fire Suppression System
      d. Fire Alarm System
      e. Security System
      f. Cable Test/Certification Reports and Startup Records
   9. Instructions: Operating, service and maintenance manual or instruction sheet for each item as requested by specifications and required for Owner's use.
   10. Shop Drawings: A complete file of final copies of all shop drawings used in construction of project.
   11. Complete set of all submittals for products used in construction of project.

B. Project Record Drawings: The Contractor shall provide one (1) complete set of project record drawings and electronic copies of scanned images of the drawings.
   1. Cloud and reference each of the following items on the Record Drawings:
      a. written addendum items
      b. Addendum Drawings
      c. Supplemental Drawings
      d. Supplemental Instructions
      e. Change Orders
      f. responses to RFI's
      g. any other deviations from the original drawings that are made in the field

2. Record final locations of underground lines by depth from finished grade and by accurate horizontal offset distances to permanent surface improvements such as buildings, curbs, edges, or walks.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.01 EXTENDED WARRANTIES

A. The entire project is warranted for a period of one (1) year from the date of substantial completion and several materials and systems require extended warranties. It is the responsibility of the General Contractor to review the Project Manual to determine the term of the extended warranties and provide the extended warranties required.

END OF SECTION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Arkansas Special Inspections Guidelines (SEAoAR SI GL 03 - 01/01/2023) in accordance with 2021 Arkansas Fire Prevention Code (based on 2021 International Building Code).

1.02 SUMMARY

A. This Section includes administrative and procedural requirements required for compliance with the International Building Code, Chapter 17, Structural Tests and Special Inspections.

B. Structural testing and special inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with other construction document requirements.
   1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the construction document requirements.
   3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this section.

C. The Owner will engage one or more qualified Special Inspectors and / or testing agencies to conduct structural tests and special inspections specified in this section and related sections and as maybe specified in other divisions of these specifications.

1.03 DEFINITIONS

A. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the building official.

B. Construction Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit. Construction Documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the registered design professional beyond those issued for a building permit.

C. Shop Drawings/Submittal Data: Written, graphic and pictorial documents prepared and/or assembled by the Contractor based on the Construction Documents.

D. Structural Observation: Visual observation of the structural system by a representative of the registered design professional's office for general conformance to the approved construction documents. Structural observations are not considered part of the structural tests and special inspections and do not replace inspections and testing by the testing agency or Special Inspector.

E. Special Inspector: A qualified person who demonstrating competence, to the satisfaction of the code enforcement official and registered design professional in responsible charge, for inspection of the particular type of construction or operation requiring special inspection. The Special Inspector shall be a licensed Professional Engineer, Engineering Intern, or a qualified representative from the testing agency who is under supervision of a licensed Professional Engineer.

F. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.

G. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.

H. Testing Agency: A qualified materials testing laboratory under the responsible charge of a licensed Professional Engineer, approved by the code enforcement official and the registered design professional in responsible charge, to measure, examine, test, calibrate, or otherwise determine the characteristics or performance of construction materials and verify confirmation with construction documents.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications:
   1. Minimum qualifications of inspection and testing agencies and their personnel shall comply with ASTM E329-03 Standard Specification for Agencies in the Testing and/or Inspection of Materials Used in Construction.
      a. Inspectors and individuals performing tests shall be certified for the work being performed as outlined in the appendix of the ASTM E329. Certification by organizations other than those listed must be submitted to the building official for consideration before proceeding with work.
   2. In addition to these requirements, local jurisdiction may have additional requirements. It is the responsibility of the testing and inspection agencies to meet local requirements and comply with local procedures.

1.05 CONFLICTING REQUIREMENTS, REPORTS, AND TEST RESULTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that

are different, but apparently equal, to the registered design professional in responsible charge for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the registered design profession in responsible charge for a decision before proceeding.

C. The Special Inspector's reports and testing agencies results shall have precedence over reports and test results provided by the Contractor.

D. Where a conflict exists between the construction documents and approved shop drawings/submittal data, the construction documents shall govern unless the shop drawings/submittal data are more restrictive. All conflicts shall be brought to the attention of the registered design professional in responsible charge.

1.06 SUBMITTALS BY SPECIAL INSPECTOR AND/OR TESTING AGENCY

A. Special Inspectors shall keep and distribute records of inspections. The Special Inspector shall furnish inspection reports to the building official, and to the registered design professional in responsible charge, Contractor, Architect, and Owner. Reports shall indicate that work inspected was done in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the Contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the building official and to the registered design professional in responsible charge prior to the completion of that phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon by the permit applicant and the building official prior to the start of work.

1. Special inspection reports and test results shall include, but not be limited to, the following:
    a. Date of inspection.
    b. Description of inspections or tests performed including location (reference grid lines, floors, elevations, etc.).
    c. Statement noting that the work, material, and/or product conforms or does not conform to the construction document requirements.
        1) Name and signature of Contractor's representative who was notified of work, material, and/or products that do not meet the construction document requirements.
    d. Name and signature of Special Inspector and/or testing agency representative performing the work.

B. Schedule of Non-Compliant Work: Each agent shall maintain a log of work that does not meet the requirements of the construction documents. Include reference to original inspection/test report and subsequent dates of re-inspection/retesting.

C. Reports and tests shall be submitted within 1 week of inspection or test. Schedule of Non-Compliant Work shall be updated daily and submitted at monthly intervals.

D. Final Report of Special Inspections. Submitted by each agent listed in the schedule of Structural Testing and Special Inspections.

PART 2 - PRODUCTS (not used)

PART 3 – EXECUTION

3.01 CONTRACTOR'S RESPONSIBILITY

A. The Contractor shall coordinate the inspection and testing services with the progress of the work. The Contractor shall provide sufficient notice to allow proper scheduling of all personnel. The Contractor shall provide safe access for performing inspection and on site testing.

B. The Contractor shall submit schedules to the Owner, registered design professionals and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring structural tests and special inspections.

C. Each Contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, or component listed in the quality assurance plan shall submit a written Contractor's statement of responsibility to the building official and to the Owner prior to the commencement of work on the system or component. The Contractor's statement of responsibility shall contain the following:
   1. Acknowledgment of awareness of the special requirements contained in the quality assurance plan.
   2. Acknowledgment that control will be exercised to obtain conformance with the construction documents approved by the building official.
   3. Procedures for exercising control within the Contractor's organization, the method and frequency of reporting and the distribution of the reports.
   4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

D. Each Contractor responsible for the construction of a main wind force-resisting system or a wind-resisting component listed in the quality assurance plan shall submit a written statement of responsibility to the building official and the Owner prior to the commencement of work on the system or component. The Contractor's statement of responsibility shall contain the following:
   1. Acknowledgment of awareness of the special requirements contained in the quality assurance plan.
   2. Acknowledgment that control will be exercised to obtain conformance with the construction documents approved by the building official.
   3. Procedures for exercising control within the Contractor's organization, the method and frequency of reporting and the distribution of the reports.
   4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

E. The Contractor shall repair and/or replace work that does not meet the requirements of the construction documents.
   1. Contractor shall engage an Engineer/Architect to prepare repair and/or replacement procedures.
   2. Engineer/Architect shall be registered in the state in which the project is located. Engineer shall be acceptable to the registered design professional in responsible charge, code enforcement official, and Owner.
   3. Procedures shall be submitted for review and acceptance by the registered design professional in responsible charge, code enforcement official, and Owner before proceeding with corrective action.

F. The Contractor shall be responsible for costs of:
   1. Re-testing and re-inspection of materials, work, and/or products that do not meet the requirements of the construction documents and shop drawings/submittal data.
   2. Review of proposed repair and/or replacement procedures by the registered design professional in responsible charge and the inspectors and testing agencies.
   3. Repair or replacement of work that does not meet the requirements of the construction documents.

3.02 STRUCTURAL OBSERVATIONS

A. Structural observations may be made periodically as determined by the registered design professional in responsible charge.

3.03 TESTING AND INSPECTION

A. Reference related specifications for the minimum level of inspections and testing. Provide additional inspections and testing as necessary to determine compliance with the construction drawings.

END OF SECTION

PART 1 - GENERAL

1.01 GENERAL SITE REQUIREMENTS

A. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways.

B. Ensure safe passage of persons around areas of construction. Conduct operations to prevent injury to adjacent buildings, structures, facilities and persons.

C. Erect temporary covered passageways as required by authorities having jurisdiction.

D. Provide dustproof partitions if required. If not indicated on the drawings, provide dustproof partitions as directed by the Architect to comply with applicable sections of the Life Safety Code.

E. Provide temporary enclosures at doors and other openings in walls as necessitated by weather conditions. Construct enclosures with fire retardant treated lumber. Tape joints and caulk to prevent dust and debris from migrating beyond construction areas. Maintain enclosures in good repair and remove when no longer needed.

F. Provide interior and exterior shoring, bracing or support as needed to prevent movement, settlement or collapse.

1.02 PROJECT SIGNS

A. General Contractor shall furnish and erect temporary construction sign at job site and remove sign at end of construction period. Paint and letter as directed by Architect to identify project, Owner, Architect and Contractor.

B. Additional signs will be provided by the Architect to be placed as directed. Signs shall be maintained throughout the project.

C. Subject to prior approval of Owner as to size, design, type, location and to local regulations, Contractor and his subcontractors may erect temporary signs for purposes of identification and controlling traffic.

1.03 JOB OFFICES AND STORAGE

A. Contractor and his subcontractors shall maintain office and storage facilities on site as may be necessary. Locate so as to cause no interference with work to be performed on the site by Owner or with Owner's operations. Consult with Architect regarding locations. Office shall have as a minimum the following items:

1. Complete set of Construction Documents including all addenda and supplemental information.

2. Layout and meeting space for Architects or Owners representative to use when visiting the site.
3. Complete job file with copies of all correspondence concerning the project.

B. Upon completion of project, or as directed by Architect, Contractor shall remove temporary structures and facilities from the site, same to become his property. Leave the premises in condition required by Contract.

1.04 SANITARY ARRANGEMENTS

A. Contractor, at beginning of Work, to provide on premises suitable temporary convenience and enclosure for use of workmen on job. Maintain in sanitary condition and remove at completion of Work or when directed by Architect.

1.05 TEMPORARY UTILITIES FOR CONSTRUCTION

A. Provide all gas and electric service required for construction purposes.

B. Provide all water required for construction purposes. Run temporary lines and provide necessary stand pipes.

C. Contractor to pay all utility charges until time of substantial completion.

1.06 TEMPORARY HEATING

A. Provide temporary heating, coverings and enclosures necessary to protect operations and materials against damage by dampness and cold, to dry out work, and facilitate completion of Work.

B. Maintain critical installation temperatures required in separate Sections of the Specifications. Repair or replace at no additional cost to Owner, any materials and work damaged by dampness, insufficient or abnormal heat.

1.07 CONSTRUCTION AIDS

A. Provide and maintain for the duration of construction temporary equipment and apparatus including scaffolds, elevators and hoists, canopies, tarpaulins, barricades, warning signs, steps, ladders, platforms, ramps, chutes, walkways, and other temporary construction aids and miscellaneous facilities as necessary for proper completion of the work; comply with pertinent safety regulations.

1.08 RUBBISH CONTAINERS

A. Provide suitable containers with covers for refuse from meals eaten on job site. Remove refuse from containers at least once in every 72 hour period. Place one container beside each drinking water facility to receive discarded paper cups. Pick up and place bottles, cans, paper and garbage of every description in covered rubbish containers continuously during day.

1.09 TEMPORARY FIRE PROTECTION

A. During construction period, provide and maintain types and forms of temporary fire protection needed to protect facilities against fire losses. Store combustible materials in recognized fire-safe locations and containers.

1.10 SECURITY

A. Provide sufficient control to prevent illegal entry or damage during nights, holidays, or other periods when work is not being executed, and such other controls as required during working hours.

1.11 REMOVAL

A. Maintain construction facilities and temporary controls as long as needed for safe and proper completion of work. Remove temporary facilities and controls as rapidly as progress of work will permit or as directed by Architect.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes: General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:
1. Section 311000 "Site Clearing" for removing existing trees and shrubs and for temporary erosion- and sedimentation-control measures if not specified in Section 015000 "Temporary Facilities and Controls".
2. Section 312000 "Earthwork" for Temporary and permanent grade changes for erosion control.
3. Section 321123 "Aggregate Base Course" for Temporary and permanent roadways.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Include plans, elevations, and sections showing trees and plants to be protected, locations of protection-zone fencing and signage, and the relationship between equipment-movement routes and material storage locations with protection zones.

C. Samples: For each type of the following:
1. Organic Mulch: **1-pint** volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree-Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1.4 INFORMATIONAL SUBMITTALS

A. Certification: From ISA certified arborist, certifying that trees indicated to remain have been protected during construction in accordance with recognized standards and that trees were promptly and properly treated and repaired when damaged.

B. Maintenance Recommendations: From ISA certified arborist, for care and protection of

trees affected by construction during and after completing the Work.

C. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1.5 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA,Licensed arborist in jurisdiction where Project is located, Current member of ASCA, Registered Consulting Arborist as designated by ASCA.

1.6 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Moving or parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Soil: Stockpiled soil mixed with planting soil of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
   1. Mixture: Well-blended mix of 2 parts stockpiled soil to 1 part planting soil.
   2. Planting soil as specified in Section 329113 "Soil Preparation"

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
   1. Type: Shredded hardwood.

C. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements: Previously used materials may be used when approved by Architect or Engineer.
   1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum **2-inch** opening, **0.148-inch-** diameter wire chain-link fabric; with pipe

posts, minimum **2-3/8-inch-** OD line posts, and **2-7/8-inch-** OD corner and pull posts; with **1-5/8-inch-** OD top rails, ; with **0.177-inch-** diameter top tension wire and **0.177-inch-** diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
   a. Height: **48 inches**.
2. Wood Protection-Zone Fencing: Constructed of two **2-by-4-inch** horizontal rails, with **4-by-4-inch** preservative-treated wood posts spaced not more than **96 inches** apart, and lower rail set halfway between top rail and ground.
   a. Height: **48 inches**.
3. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with **2-inch** maximum opening in pattern and weighing a minimum of **0.4 lb/ft.**; remaining flexible from **minus 60 to plus 200 deg F**; inert to most chemicals and acids; minimum tensile yield strength of **2000 psi** and ultimate tensile strength of **2680 psi**; secured with plastic bands or galvanized-steel or stainless steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than **96 inches** apart. High visibility orange color.
   a. Height: **48 inches**.
4. Plywood Protection-Zone Fencing: Plywood framed with four 2-by-4 inch rails, with 4-by-4-inch preservative-treated wood posts spaced not more than 96 inches apart
   a. Height: 48 inches.
5. Gates: Single- swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width As indicated.

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced, legibly printed with nonfading lettering, stating "Notice Tree Preservation Area DO NOT ENTER" or other verbiage as required by Urban Forester for the jurisdiction in which work will take place.

PART 3 - EXECUTION

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

B. Reports: All trees disturbed or damaged within a tree protection area or easement are to be assessed and a report produced by an arborist. All trees to remain are to be evaluated individually in a report by an arborist. Report is to be reviewed and approved by the Landscape Architect. All associated cost of arborist and associated work recommended in reports are to be at the contractor’s expense. Including but not limited to pruning, dead wooding, tree removal and legal disposal of material offsite.

END OF SECTION

PART 1 -GENERAL (Not Used)

1.1 MATERIALS

A. Mulch: Use one of the following:
   1. Straw or hay, certified weed seed free 'clean'.
   2. Erosion control matting or netting, bio- or photo-degradable straw, coconut, coir or jute.
   3. 100% Wood Fiber Hydroseeding Mulch

B. Grass Seed for Temporary Cover: If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.
   1. Summer Temporary Cover: May -September shall be Browntop Millet seeded at 100 lbs per acre and Plains Coreopsis seeded at 2 lbs per acre.
   2. Winter Temporary Cover: September-May – shall be Cereal Rye -Secale cereale grain – 200 lbs/acre.

C. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
   1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D 4751.
   2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D 4491.
   3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D 4355 after 500 hours exposure.
   4. Tensile Strength: 100 lb-f, minimum, in cross-machine direction; 124 lb-f, minimum, in machine direction; when tested in accordance with ASTM D 4632.
   5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D 4632.
   6. Tear Strength: 55 lb-f, minimum, when tested in accordance with ASTM D 4533.
   7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

D. Silt Fence Posts: One of the following, minimum 5 feet long:
   1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot.

E. Gravel: See Section 32 1123 for aggregate.

PART 2 -EXECUTION

2.1 INSTALLATION

A. Traffic-Bearing Aggregate Surface:
   1. Excavate minimum of 6 inches.
   2. Place geotextile fabric full width and length, with minimum 12 inch overlap at

joints.

3. Place and compact at least 6 inches of 1.5 to 3.5 inch diameter stone.

B. Silt Fences:

1. Store and handle fabric in accordance with ASTM D 4873.
2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
4. Where slope gradient is steeper than 3-1:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
5. Install with top of fabric at nominal height and embedment as specified.

2.2 MAINTENANCE

A. Contractor shall maintain, repair, replace or add best management practices and structural erosion and sediment controls as necessary or required to maintain project compliance with all applicable local, state and federal requirements, including Project specific Permits.

END OF SECTION

PART 1 - GENERAL

1.01 CLEANING AND WASTE REMOVAL

A. Progress Cleaning:
1. The premises and the job site shall be maintained in a reasonable neat and orderly condition and kept free from accumulations of waste materials and rubbish during the entire construction period. Remove crates, cartons, and other flammable waste materials or trash from the work areas at the end of each working day. Do not allow debris to blow onto adjoining properties. Respond immediately to request from adjoining property owners to remove any debris that does manage to show up on adjoining properties. Collect and remove waste materials, debris, and rubbish from site weekly, daily if necessary and dispose off-site.
2. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
3. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

B. Final Cleaning:
1. Use cleaning materials and agents recommended by manufacturer or fabricator of surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property, or that might damage finished surfaces.
2. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's published instructions.
3. Complete following cleaning operations before requesting inspection for Substantial Completion.
    a. Clean Project Site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste materials, litter and foreign substances. Sweep paved areas broom clean. Remove petro-chemical spills, stains and other foreign deposits. Rake grounds to a smooth even-textured surface.
    b. Remove tools, construction equipment, machinery and surplus material from Project Site.
    c. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    d. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics and similar spaces.
    e. Broom clean concrete floors in unoccupied spaces.
    f. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo if required.

g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped, scratched or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces. Do not use razor blades to clean glass. Any scratches on the glass caused by the cleaning process will be cause for the removal and replacement of the damaged glass at the Contractor's expense.

h. Remove labels that are not permanent labels.

i. Touch-up and otherwise repair and restore marred exposed finishes and surfaces. Replace finishes and surfaces that can not be satisfactorily repaired or restored, or that show evidence of repair or restoration. Do not paint over "UL" and similar labels, including mechanical and electrical name plates.

j. Wipe surfaces of mechanical and electrical equipment, and other similar equipment. Remove excess lubrication, paint and mortar droppings and other foreign substances.

k. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

l. Replace all disposable filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills. Clean ducts, blowers, and coils if units were operated without filters during construction.

m. Clean light fixtures, lamps, globes and reflectors to function with full efficiency. Replace burned out bulbs, and defective and noisy starters in fluorescent and mercury vapor fixtures.

n. Leave Project clean and ready for occupancy.

4. Engage an experienced licensed exterminator to make a final inspection, and rid Project of rodents, insects, and other pests. Comply with regulations of local authorities having jurisdiction.

5. Remove temporary protection and facilities installed during construction to protect previously completed installations during remainder of construction.

6. Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from Project Site and dispose of in accordance with requirements of local authorities having jurisdiction.

   a. Extra materials of value that remain after completion of construction and have become the Owner's property are to be stored as directed by Owner.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Selective demolition and removal of selected site elements.
   2. Abandonment and removal of existing utilities and utility structures.

B. Related Requirements:
   1. Section 312000 – Earthwork

C. References
   1. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
   2. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2004.

1.2 QUALITY ASSURANCE

A. Demolition Firm: Company specializing in the type of work required.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.
5. Concrete toppings.

****ARCH****

B. Related Sections:
1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
2. Section 321313 "Concrete Paving" for concrete pavement and walks.
3. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
2. Submit substantiating data for each concrete mix design contemplated for use to the Architect no less than four weeks prior to first concrete placement. Data for each mix shall include the following:

a. Mix identification number (unique for each mix submitted).
b. Statement of intended mix use.
c. Mixture proportions.
d. Water/cementitious materials ratio.

e. Wet and dry unit weight.
f. Total air content.
g. Design slump and allowable range after additions of all admixtures.
h. Time limits on discharge: If time of discharge exceeds ACI 301 90 minute time limit, submit concrete properties criteria at permissible time of discharge and additional special inspection and testing requirements associated with time limits.
i. Compressive strength tests.

C. Before submitting concrete design mixtures to the architect for review, contractor shall review concrete design mixture for applications, state on the submittal where the concrete mix will be used, establish procedures for ensuring quality of concrete materials and verify suitability of mix design for placement and finishing.

D. Mass concrete thermal control plans. See "Concrete Mixtures, General – Mass Concrete Performance and Design Requirements" section of this specification.

E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Show all reinforcing, top and bottom profile of concrete element, supports below, including beams, columns and walls, grade beams, concrete walls, joists, etc. framing into element.
2. Provide one continuous elevation at 1/4" (1:48) scale for all beams, joists or walls in a continuous line. Show pockets and openings in shear walls, structural slabs, beams, elevations of top of beams, walls, columns, sections through beams, pilasters, columns, and placing sequence of reinforcing for items with more than one reinforcing layer.
3. Show locations of approved construction joints, locations of pour strips, splices of reinforcing, type of splice used and splice location. Identify all ASTM A706 and epoxy coated reinforcing locations.

F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of Architect.

****ARCH****

G. Samples: For [**waterstops**] [**vapor retarder**] <**Insert products**>.

1.5 INFORMATIONAL SUBMITTALS

****ARCH****

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Bonding agents.
8. Vapor retarders.

9. Repair materials.
10. Supplementary Cementitious materials.
11. Corrosion inhibitors.

B. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates: Submit test reports indicating that aggregates are not potentially reactive based on the ASTM C295 or ASTM 1260 testing limits set forth in section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). Alternatively, submit ASTM C1567 test reports indicating that the combination of mix ingredients reduces the expansion due to Alkali aggregate reactivity such that the mix complies with section 5.2 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). All tests for submitted reports shall have been performed within one year of the submittal date.

****ARCH****

C. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

D. Minutes of preinstallation conference.

E. Placement Notification: Submit notification to Architect at least 24 hours in advance of placement.

F. Proposed location of saw cut joints not indicated on Drawings.

G. Curing compound data demonstrating specified moisture loss performance.

H. Evaporative retarder product and application data.

I. Mass concrete thermal monitoring records.

1.6 QUALITY ASSURANCE

****ARCH****

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Associate and a supervisor who is an ACI-certified Concrete Flatwork Finisher.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
3. Personnel inspecting concrete reinforcing steel have current certification as an ACI Concrete Construction Inspector or have experience in concrete construction acceptable to the Architect.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

F. Formwork: Contractor shall be responsible for design and engineering of formwork. Design of formwork and preparation of formwork drawings shall be performed under supervision of a qualified engineer registered in the state of the project.

G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

****ARCH****

H. Mockups: Cast concrete [**slab-on-grade**] [**and**] [**formed-surface**] panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

I. Preinstallation Conference: Conduct conference at Project site or by video conference call**.**

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Ready-mix concrete manufacturer.
c. Concrete subcontractor.
d. Special concrete finish subcontractor.
e. Owner’s Testing/Inspection Agency.
f. Engineer by video call
g. Architect by video call

****ARCH****

2. Review as applicable to Project special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving floor and slab flatness and levelness, floor and slab flatness and levelness measurement, concrete repair procedures, concrete protection, field sampling procedures for concrete cylinders and air testing, initial curing and field curing of field test cylinders (ASTM C31/C31M), protection of field cured field test cylinders.
3. Minutes of the meeting shall be recorded by Contractor and distributed to all parties within five days. Provide one copy to Owner’s representative and Architect.

J. Record of Work: Maintain a record listing time and date of all structural concrete placement. Such record shall be kept until completion of Project and shall be available to Architect for examination at any time.

K. Pre-Placement Inspection: Formwork installation, reinforcing steel placement and installation of all items to be embedded or cast into concrete shall be verified by Contractor prior to placement.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement if present.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

****ARCH****

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads. Provide factory-made sections with curved, closed faces around drilled piers. Curved face diameter shall match drilled pier diameter. Void forms intended to remain in place after concrete placement shall degrade sufficiently within three months after concrete placement.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 1/2" inch (38 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

****ARCH****

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed, where welding of reinforcement or field bending is noted on Drawings.

C. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 ASTM A 706/A 706M for bars that may be field bent, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M for bars that are prefabricated, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

D. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

E. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

F. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars, ASTM A 775/A 775M epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire,

plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

E. Mechanical Connectors: Mechanical couplers shall develop in tension or compression, as required, at least 125% of bar yield strength. Connectors shall comply with ICC-ES acceptance criteria, ACI 133.

F. Deformed Bar Anchors: Heads on deformed bar anchors shall conform to ASTM A970 including Annex A1 requirements for class HA heads.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Ordinary Portland Cement: ASTM C 150, Type as indicated on drawings, gray. Alternate cementitious materials when proposed to control alkali-silica reactions and tested as part of a representative concrete mix in accordance with ASTM C1567, may be used subject to approval.

2. Blended Hydraulic Cement: ASTM C 595, Type IL, portland-limestone cement.
3. Supplementary Cementitious Materials (SCM): Of proportions and type to meet concrete performance criteria as indicated in the structural drawings. Available SCM's that may be incorporated into the Work include, but are not limited to, the following:
   a. Fly Ash: ASTM C 618, Class F or C
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
   c. Silica Fume: ASTM C 1240, amorphous silica.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. All coarse and fine aggregate shall be tested per ASTM C 295 or ASTM C 1293 in accordance with section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association).

1. Maximum Coarse-Aggregate Size: As indicated on Drawings.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable or ASTM C 1602 tested non-potable which is compatible with admixtures. [Provide sample and obtain approval from architect of color and finish of exposed concrete mixes where non-potable water is used.]

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
7. Mid-Range Water Reducing Admixture: ASTM C 494/C 494M, Type A.
8. Carbon Dioxide Mineralization: ASTM C494 Type S.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and not containing more chloride ions than are present in municipal drinking water and complying with ASTM C 494/C 494M, Type C for set accelerating use and ASTM C1582 for corrosion-inhibitor use.

1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
   b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
   c. Euclid Chemical Company (The), an RPM company; ARRMATECT, EUCON BCN, or EUCON CIA.
   d. Grace Construction Products, W. R. Grace & Co.; DCI.
   e. Sika Corporation; Sika CNI.

2. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:

   a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
   b. Cortec Corporation; MCI- 2000 or 2005NS.
   c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
   d. Sika Corporation; FerroGard 901.

****ARCH****

2.6 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces. Shall not be less than 40% silane or 9% polysiloxane or shall be 20% siloxane. Provide certification of 90% chloride screen effectiveness when tested in accordance with the procedure in NCHRP Report Number 244 “Southern Climate Exposure”.

B. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces. Shall not be less than 40% silane or 9% polysiloxane or shall be 20% siloxane. Provide certification of 90% chloride screen effectiveness when tested in accordance with the procedure in NCHRP Report Number 244 “Southern Climate Exposure”.

C. Penetrating Liquid Floor Treatment for Vehicular Surfaces: Material suitable for application on horizontal surfaces subject to vehicle traffic shall contain not less than 40% silane. Provide certification of 95% chloride screen effectiveness when tested in accordance with procedure of NCHRP Report Number 244 “Southern Climate Exposure” at manufacturer’s recommended rate of application. Also

provide certification that product meets Alberta Transportation and Utilities BT-003 at 45% relative moisture results greater than 85% both initial and post abrasion performance.

****ARCH****

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. VOC Content: Evaporation retarders shall have a VOC content of 780 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
   b. BASF Construction Chemicals - Building Systems; Confilm.
   c. ChemMasters; SprayFilm.
   d. Conspec by Dayton Superior; Aquafilm.
   e. Dayton Superior Corporation; Sure Film (J-74).
   f. Edoco by Dayton Superior; BurkeFilm.
   g. Euclid Chemical Company (The), an RPM company; Eucobar.
   h. Kaufman Products, Inc.; Vapor-Aid.
   i. Lambert Corporation; LAMBCO Skin.
   j. L&M Construction Chemicals, Inc.; E-CON.
   k. Meadows, W. R., Inc.; EVAPRE.
   l. Metalcrete Industries; Waterhold.
   m. Nox-Crete Products Group; MONOFILM.
   n. Sika Corporation; SikaFilm.
   o. SpecChem, LLC; Spec Film.
   p. Symons by Dayton Superior; Finishing Aid.
   q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
   r. Unitex; PRO-FILM.
   s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Film must chemically break down in a four to six week period. Membrane-Forming Curing Compounds shall have a VOC content of 350 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Curing and sealing Compounds shall have a VOC content of **[100] [350]** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Class A. Curing and sealing Compounds shall have a VOC content of **[100] [350]** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 RELATED MATERIALS

****ARCH****

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber

****ARCH****

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

****ARCH****

C. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

****ARCH****

D. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.9 REPAIR MATERIALS

****ARCH****

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

****ARCH****

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than **5000 psi** at 28 days when tested according to ASTM C 109/C 109M.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Supplementary Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement while meeting the embodied carbon limits listed on the drawings. Where indicated on the drawings, limit percentage, by weight, of cementitious materials other than Portland cement in concrete.

C. Limit water-soluble, chloride-ion content in hardened concrete as listed on the drawings.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Performance and Design Requirements:

1. Shrinkage: Shrinkage strain, determined in accordance with ASTM C 157 as amended and modified herein, shall not exceed the values below for each concrete class:

   a. Amendments and modifications to ASTM C 157:

      1) Storage: After initial 24-hour comparator reading, specimens are placed back in lime saturated water until age of seven days. At seven days another comparator reading is taken. This reading is used as the base reading which is used to calculate percent shrinkage. The specimens are stored at 50% humidity and 73° F.
      2) Test Reports: Report gage length (average of three) after 4, 7, 14, 28, and 56 days. In addition to the information required by ASTM C 157, Section 11, shrinkage test reports shall include gage lengths (initial length measurements) used to determine reported shrinkage strains.

   b. 28 Day Shrinkage Strain: Shrinkage strains shall not exceed the following:
      1) Concrete for slab-on-grade placed directly on vapor barrier: 0.046%.
2. Mass Concrete Requirements: See drawings for dimensional limits on structural elements requiring a thermal control plan. Contractor to submit thermal control plan for mass concrete elements following the requirements of ACI 301-20, Section 8. Thermal control plan for mass concrete shall be prepared by qualified concrete specialty engineer. Maximum post placement concrete temperature shall not exceed 160°F unless substantiating data is submitted indicating higher temperature is acceptable. Maximum differential temperature shall not exceed 35°F.

Thermal monitoring to verify compliance with thermal control plan is required. Monitoring locations shall be indicated in plan. Qualified Consultants: MJ2 Consulting, mj2consulting.com. Other qualified specialty consultants are acceptable; submit qualifications.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion structural normal-weight concrete mixture as noted on Drawings, unless aggregates are "potentially reactive" with alkalis based on the ASTM C 295 or ASTM C 1260 or ASTM C 1293 testing limits of Section 5.1 of "Guide Specification of Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). When aggregates are "potentially reactive", compliance with Section 5.2 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association) must be established through ASTM C 1567 testing for proposed alternate concrete mixture. Submit test reports in accordance with Part I of this Specification.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Concrete adjacent to elevator hoistway shall be installed to tolerances required by elevator manufacturer.

****ARCH****

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. [**Class A, 1/8 inch (3.2 mm)**] <**Insert dimension**> for smooth-formed finished surfaces.
2. [**Class B, 1/4 inch (6 mm)**][**Class C, 1/2 inch (13 mm)**][**Class D, 1 inch (25 mm)**] <**Insert dimension**> for rough-formed finished surfaces.
3. The permissible irregularity is a cumulative value due to all sources including layout, plumbness, member size, formwork offsets, joints, and member levelness. The permissible irregularity shall also apply between adjacent concrete surfaces on opposite sides of construction joint, expansion joint or shrinkage pour strip if present.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

ARCH

H. [**Chamfer**][**Do not chamfer**] exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement. Form release agent shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

ARCH

M. All formwork surfaces that support concrete exposed to view must be accepted by Architect prior to concrete placement.

ARCH

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

    a. Tolerance of Embedded Items: Comply with ACI 117.

        1) Anchor Rods:
            a) Plumbness: Within +/- 1/16 inch over anchor rod projection.

        2) Embedded Plates and Weldments:
            a) Location: +/- 1 inch vertical, +/- 1 inch horizontal.
            b) Plumb and Alignment: 1/4 inch in 12 inches (1:48).

2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated. Where masonry or veneer intersects concrete, provide one vertical dovetail slot for each 8 inches of masonry thickness. Where concrete serves as the backup, space slots at 16 inches on center.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
3. Leave formwork and shoring in place a minimum of 15 days after concrete placement unless reshoring is used.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

D. Reshoring:

1. If formwork and shoring are removed before concrete is 15 days old, reshoring shall remain in place a minimum of 15 days after placement irrespective of concrete strength.
2. For multi-story construction, reshoring shall remain in place a minimum of 15 days after placing of concrete deck above irrespective of concrete strength.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete in accordance ASTM E1643.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Size, length, number and placement of supports shall be sufficient to maintain reinforcing position within specified tolerances during construction traffic and concrete placement.

E. On vertical formwork, use approved bar chairs or spacers as required to maintain concrete cover and bar position. Do not staple or use any other metallic fastener to secure bolsters, chairs, etc. to formwork for concrete surfaces exposed to exterior.

F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

H. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside pilasters integral with walls, near corners, and in concealed locations where possible. Locate at centerline of support or middle third of span.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

3. Interior Slabs-on-Grade to Receive Carpet or Wood Floor Covering: Construct slabs as large a placement area as practical. Unless noted otherwise on Drawings, locate construction joints on column centerlines. Provide control joints at column centerlines and at intervals not more than 30 feet each way.
4. All Other Interior Slabs-on-Grade: Unless noted otherwise on Drawings, locate construction joints on column centerlines. Locate control joints where shown on Drawings. If not shown, provide control joints at column centerlines and at intervals not more than 10 feet each way.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Joints in Slabs-on-Metal Deck: Locate construction joints as shown on Drawings. For slabs with welded wire reinforcing, continue reinforcing through construction joint and lap in adjacent pour. For slabs without welded wire reinforcing, provide #4 bar 4 feet in length spaced at 12 inches on center staggered along the joint. Do not provide control joints.

F. Topping Slabs Exposed to View: Locate control joints where shown on the Contract Drawings. If not shown, locate topping slab control joints at column centerlines, over girders and at intervals not more than 10 feet each way.

****ARCH****

3.7 WATERSTOPS

A. ~~Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions~~.

B. ~~Self Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable~~.

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section

cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   a. Slabs supported by metal deck shall be gaged to provide the specified slab thickness over beams.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

****ARCH****

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces [**not exposed to public view**] <**Insert locations**>.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces [**exposed to public view,**] [**to receive a rubbed finish,**] [**to be covered with a coating or covering material applied directly to concrete**] <**Insert locations**>.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

****ARCH****

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces [**indicated**] [**and**] [**to receive concrete floor toppings**] [**to receive mortar setting beds for bonded cementitious floor finishes**] <**Insert locations**>.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces [**indicated**] [**to receive trowel finish**] [**and**] [**to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo**] <**Insert locations**>.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces [**indicated**] [**exposed to view**] [**or**] [**to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system**] <**Insert locations**>.

****ARCH****

E. Top of surface for slabs

1. Slabs on ground shall be +/- .75".
2. Formed suspended slabs, before removal of supporting shores +/- .75"

F. Slab surface finish tolerance: Finish slab surfaces to the following tolerances according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
   1. Slabs on grade (conventional): Specified overall values of flatness, SOF(F) 20; and of levelness, SOF(L) 15; with minimum local values of flatness, MLF(F) 17; and of levelness, MLF(L) 15.
   2. Slabs on grade (moderately flat): Specified overall values of flatness, SOF(F) 25; and of levelness, SOF(L) 20; with minimum local values of flatness, MLF(F) 17; and of levelness, MLF(L) 15.
   3. Slabs on grade (flat): Specified overall values of flatness, SOF(F) 35; and of levelness, SOF(L) 25; with minimum local values of flatness, MLF(F) 24; and of levelness, MLF(L) 17; for slabs-on-grade.
   4. Suspended formed slabs: Specified overall values of flatness, SOF(F) [30]; and of levelness, SOF(L) [20]; with minimum local values of flatness, MLF(F) [20]; and of levelness, MLF(L) [15]. Values are prior to form work removal.
   5. Suspended slabs on metal deck: Specified overall values of flatness, SOF(F) [30]; and no limit for levelness, SOF(L); with minimum local values of flatness, MLF(F) [20]; and of no limit for levelness, MLF(L).
   6. Slabs on grade (very flat): Specified overall values of flatness, SOF(F) 45; and of levelness, SOF(L) 35; with minimum local values of flatness, MLF(F) 30; and of levelness, MLF(L) 24.
   7. Slabs on grade (Super flat): Specified overall values of flatness, SOF(F) 60; and of levelness, SOF(L) 40; with minimum local values of flatness, MLF(F) 36; and of levelness, MLF(L) 27.
   8. Floor Finishes that require local flatness numbers more restrictive than those specified above shall be achieved by the use of floor leveling compound or by grinding.
   9. At construction joints, finish and measure surface so gap at any point along the joint between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch. Grind or fill-in surface of concrete to meet limits above at construction joints.

****ARCH****

   10. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4.

G. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces [**indicated**] [**where ceramic or quarry tile is to be installed by either thickset or thin-set method**]. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

H. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

****ARCH****

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Moisture-

retaining-cover shall be inspected each day by Contractor. Any areas which do not show condensation on underside of cover or any slab areas which are not wet shall be immediately rewetted and cover replaced to prevent moisture loss.

a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

****ARCH****

3.13 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than [**3**] [**7**] [**14**] [**28**] days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.

1. Machine grind floor surfaces to receive polished finishes level and smooth [**and to depth required to reveal aggregate to match approved mockup**].
2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
3. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
4. Control and dispose of waste products produced by grinding and polishing operations.
5. Neutralize and clean polished floor surfaces.

C. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

****ARCH****

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [**one**] [**six**] month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning and that are unacceptable to Architect. Allow Architect and Structural Engineer to observe concrete surfaces upon removal of forms and prior to repair of surface defects. Defects in structural concrete shall be brought to the attention of the Architect and Structural Engineer.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template. Submit proposed repair to Architect for review prior to commencement of work.

1. Repair finished surfaces containing defects that are unacceptable to Architect. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.031 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.16 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings

3.17 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Penetrating concrete floor sealer.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

C. Manufacturer's literature and complete color selection chart.

1.04 QUALITY ASSURANCE

A. Test a minimum 4 ft. by 4 ft. area on cured concrete. Use the manufacturer's application instructions. Let test area protective treatment cure before inspection. Keep test panels available for comparison throughout the protective treatment project.

PART 2 - PRODUCTS

2.01 FLOOR SEALER

A. MANUFACTURER: Onyx Concrete Coatings, 2K CRU WB (Gloss or Matte) – ONYX Coatings

B. Material: 2K CRU WB Matte), High Performance Two-Component Polyurethane

C. Product Data
Volumetric Ratio: 3 to 1
Application Temp: 65-90°F and 5°F above dew point
Solids: 51%
Thinning: Not required
Working time on floor: 30-40 minutes
Cure Time: 18 hours (walking)
48 hours (traffic)

Critical recoat time: 24 hours
Shelf life: 12 months
USDA Food and Beverage: Meets requirements
Cure time, pot life, and working time are based on a slab temperature of 70-75 F°, and will change accordingly as airflow and temperature changes. Thinner applications increase cure times, while thicker applications decrease it. Wait 28 days before applying over new concrete.

D. Physical Properties

Property	Value	Reference
V.O.C.	< 50 g/l	ASTM D 2369-81
Matte 60 °	Gloss 60 °	
90	90	ASTM D 823
ASTM D 823		
Flexibility	Pass	ASTM D 522
Bond to Concrete	350 psi	ASTM D 4541
Taber Abrasion	Loss/1000 Cycles = 45 mg	ASTM D 4060
CS 17 Wheels		
Volume Solids	51 %	ASTM D 2697
Pencil Hardness	3H	ASTM D 3363

E. CHEMICAL RESISTANCE

Diesel Fuel	NE
Coolant	NE
Brake Fluid	SD
Transmission Fluid	SD
Power Steering Fluid	SD
Ammonia 5%	NE
Mineral Spirits	NE
Sodium Hydroxide 5%	NE
Sulfuric Acid 5%	NE

Note: The above guide is based on 24 hour exposure of the listed chemical at 72 degrees F (22 degrees C)

Key: NE = No Effect, SD = Slight Dulling, Above chart serves as a guideline only. Testing samples can be furnished upon request.

PART 3 - EXECUTION

3.01 SURFACE EVALUATION

A. New Concrete Surfaces: Allow new poured-in-place concrete to cure a minimum of 28 days at 75°F (24°C). Verify concrete dryness in accordance with ASTM F 1869 “Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride” (moisture vapor transmission should not exceed three pounds per 1,000 square feet in a 24 hour period), F 2170 “Standard Test Method for Determining Relative Humidity in Concrete using in situ Probes” (relative humidity should not exceed 80%), or D 4263 “Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method” (no moisture present). Note: The testing listed above cannot guarantee avoidance of future moisture related problems particularly with existing

concrete slabs. This is especially true if the use of an under slab moisture vapor barrier cannot be confirmed or concrete contamination from oils, chemical spills, unreacted silicates, chlorides or Alkali Silica Reaction (ASR) is suspected.

3.02 COVERAGE

A. When used as a finish coat over an existing coating, estimate coverage between 350-500 Sq Ft / gal. When used for the 2K Grind & Seal System, apply the first coat 300-400 Sq Ft / gal. Apply the second coat at 400-500 Sq Ft / gal. Always apply in thin coats. As with most water-based products, thick coats can result in trapped water in the film and thick areas will remain white. Do not allow puddling. Brush out any puddled material that pools in cracks, divots or low spots. For thicker films, simply apply additional thin coats.

3.03 SURFACE PREPARATION

A. When used as a finish coat over an existing coating, lightly use a sanding screen to create a smooth surface. Remove all dust prior to application (e.g., tack rag, microfiber). Stay within the critical recoat window.

B. When used in the 2K Grind & System, before the coating is applied, the concrete must be:
   1. Clean – Contaminants removed
   2. Profiled – Surface mechanically prepared
   3. Sound – Cracks repaired
   4. Mechanical methods are required for preparing concrete prior to coating application. The concrete profile should be approximately a CSP 2, scratch free surface. Typically, a 30/40, 50/60 or 60/80 level, in either one or two passes is recommended, depending: on the condition of the concrete (strength, porosity, hardness, flatness, etc.), size/weight of equipment used, skill/method of the installer, and desired finish from the end user. Always, provide a mockup sample prior to installation as the grinding scratches may vary with different substrates and their porosity.

3.04 MIXING

A. The mix ratio of the 2K CRU WB is 3 to 1 by volume. That is, 3 parts of A (resin), to 1 Part B (isocyanate). Mix Part A and Part B together at medium speed for 2 minutes under mechanical agitation with a jiffy paint mixer.

B. Pour the Part A into a mixing bucket. Add the Part B (in the correct 3:1 ratio), and mix 2 minutes until uniform, scraping the sides to insure a uniform mix. Always use clean mixing buckets to prevent contamination of the product.

C. As is the case with all water-based polymers, any mixed resin left in the bucket may take several days to harden with the lid off. The 2K CRU WB has a very long pot life. The mixed product will remain in a liquid form for many hours with exposure to air before slowly turning to a gel form. Leftover mixed material should be rolled out onto a substrate such as cardboard in multiple coats in order for product to properly harden for proper disposal.

3.05 APPLICATION PROCESS

A. Apply the 2K CRU WB at the correct coverage rate, whether used to go over an epoxy coating or as a 2K Grind & Seal System. (See Coverage section.) Using a 3/8″ non-shedding roller cover, quickly rollout the floor. Immediately after, cross roll the coating in the opposite direction avoiding roller marks. Additional coats will increase thickness and durability.

B. When applying the primer coat for the 2K Grind & Seal system, the 2K CRU WB will provide a darker finish. The 2K CRU WB primer coat can be substituted with the Epoxy WB Fast. This will provide a lighter finish and faster cure time in between coats. Epoxy WB Fast must be used as the primer coat before applying 2K CRU WB over a cementitious overlayment/topping. To achieve a slip-resistant finish, lightly broadcast aluminum oxide (80-120 grit) into the system and then backroll. It is always best to provide a mockup sample to determine the needs of the coefficency of friction as outlined by ANSI A137.1. Use the mock up to ensure the size of aggregate and amount used does not make the floor too difficult to clean and maintain.

3.06 CLEANUP

A. 2K CRU WB while in a liquid state may be cleaned up with water and degreaser. Otherwise a strong solvent may be required while 2K CRU WB is setting up.

3.07 MAINTENANCE

A. Refer to the ONYX Maintenance and Cleaning Guidelines.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

****ARCH****

1.2 SUMMARY

A. Section Includes:

1. Precast structural concrete.
2. Precast structural concrete with [**thin-brick**] [**stone**] facings.
3. Precast structural concrete with commercial architectural finish.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for placing connection anchors in concrete.
2. Division 03 Section “Structural Grouting” for grouting of precast concrete joints.
3. Division 04 Section "Unit Masonry" for inserts or anchorages required for precast concrete slab connections.
4. Division 05 Section "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
5. Division 05 Section "Metal Fabrications" for kickers and other miscellaneous steel shapes.
6. Division 07 Section "Sheet Metal Flashing and Trim" for flashing receivers and reglets.
7. Division 07 Section "Penetration Firestopping" for joint-filler materials for fire-resistance-rated construction.
8. Division 07 Section "Joint Sealants" for elastomeric joint sealants and sealant backings.

****ARCH****

1.3 DEFINITION

A. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, preapproved by Architect.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

1. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318.

    a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of minus 18 to plus 120 deg F.

****ARCH****

2. Fire-Resistance Rating: Provide sufficient concrete cover to comply with the following fire rating per the governing building code.

    a. **[<Roof Units: [Two hours] [_____]>]**
    b. **[<Floor Units: [Two hours] [_____]>]**
    c. **[<Wall Units: [Two hours] [_____]]>**
    d. **[<Beams: [Two hours] [_____]>]**
    e. **[<Columns: [Two hours] [_____]>]**

1.5 SUBMITTALS

****ARCH****

A. Product Data: For each type of product indicated submit only upon request of the Architect.

B. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests. Submit only upon request of the Architect.

C. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.

****ARCH****

1. **[[**Indicate joints, reveals, and extent and location of each surface finish.**]]**
2. **[[**Indicate separate face and backup mixture locations and thicknesses.**]]**
3. **[[**Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.**]]**
4. **[[**Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.**]]**
5. **[[**Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.**]]**
6. **[[**Include and locate openings larger than by 10 inches.**]]**
7. **[[**Indicate location of each precast structural concrete unit by same identification mark placed on panel.**]]**
8. **[[**Indicate relationship of precast structural concrete units to adjacent materials.**]]**
9. **[[**Indicate locations and details of brick units, including corner units and special shapes, and joint treatment.**]]**
10. **[[**Indicate estimated camber for precast floor slabs with concrete toppings.**]]**
11. **[[**Indicate shim sizes and grouting sequence.**]]**
12. **[[**Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the

appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.**]]**

****ARCH****

D. Samples:

1. **[[**For each type of finish indicated on exposed surfaces of precast structural concrete units with architectural finish, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.**]]**

    a. **[[**Where other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.**]]**

2. **[[**Samples for each thin- or half-brick unit required, showing full range of color and texture expected. Include Samples showing color and texture of joint treatment.**]]**

    a. **[[**Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.**]]**
    b. **[[**Grout Samples for Verification: Showing color and texture of joint treatment.**]]**

E. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

    a. Submit loading diagrams and performance criteria used in the design, including tolerance assumed, for review and acceptance.
    b. Submit one set of stamped and signed design calculations for record only, calculations will not be returned.

****ARCH****

    c. Include calculated fire-resistance analysis.

F. Qualification Data: For [**Installer**] [**fabricator**] [**testing agency**].

G. Welding certificates.

H. Grout Installation and Quality Control Plan: See 036000 “Structural Grouting” for additional requirements.

****ARCH****

I. Material Certificates: For the following, from manufacturer: Upon request of the Architect submit material certifications.

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Structural-steel shapes and hollow structural sections.

****ARCH****

6. **[[**Brick units and accessories.**]]**
7. **[[**Stone anchors and accessories.**]]**

J. Material Test Reports: For aggregates. Upon request of the Architect submit material certifications.

K. Source quality-control reports.

L. **[[**Field quality-control[**and special inspection**] reports.**]]**

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Participates in PCI's Plant Certification program at time of bidding and is designated a PCI-certified plant as follows:

a. Group C, Category C4 - Prestressed Deflected Strand Structural Members.
b. Group CA, Category C4A - Prestressed Deflected-Strand Structural Members.

B. Installer Qualifications: A precast concrete erector qualified at time of bidding, as evidenced by PCI's Certificate of Compliance, to erect Category S2 - Complex Structural Systems.

C. Design Standards: Comply with ACI 318 and design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

E. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D.1.1M, "Structural Welding Code - Steel."
2. AWS D1.4, "Structural Welding Code - Reinforcing Steel."

****ARCH****

F. **[[**Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets the prescriptive requirements of authorities having jurisdiction or has been calculated according to [**ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies,"**] [**PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"**] and is acceptable to authorities having jurisdiction.**]]**

****ARCH****

G. **[[**Sample Panels: After sample approval and before fabricating precast structural concrete units with [**architectural finish**] [**thin-brick facing**] [**stone facing**], produce a minimum of [**2**] <**Insert number**> sample panels approximately [**16 sq. ft. (1.5 sq. m)**] <**Insert size**> in area for review by Architect. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.**]]**

1. **[[**Locate panels where indicated or, if not indicated, as directed by Architect.**]]**

2. **[[**Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.**]]**
3. **[[**After approval of repair technique, maintain one sample panel at fabricator's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.**]]**
4. **[[**Demolish and remove sample panels when directed.**]]**

****ARCH****

H. **[[**Mockups: After sample panel approval but before production of precast structural concrete units with [**architectural finish**] [**thin-brick facing**] [**stone facing**], construct full-sized mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.**]]**

1. **[[**Build mockup as indicated on Drawings including [**sealants**] <**Insert construction**> and precast structural concrete units with an architectural finish complete with anchors, connections, flashings, and joint fillers.**]]**
2. **[[**Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.**]]**
3. **[[**Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.**]]**

I. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.

D. Lift and support units only at designated points shown on Shop Drawings.

1.8 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fabricators: Subject to compliance with requirements, provide products by one of the following:

1. Rocky Mountain Prestress
2. Stresscon Corporation
3. Or Approved Equal

****ARCH****

2.2 [[MOLD MATERIALS]]

A. **]]**Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.**]]**

1. **[[**Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.**]]**

B. **[[**Form Liners: Units of face design, texture, arrangement, and configuration [**indicated**] [**to match those used for precast concrete design reference sample**]. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.**]]**

C. **[[**Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.**]]**

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, **Grade 60** or ASTM A 706/A 706M, deformed bars, assembled with clips.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.4 PRESTRESSING TENDONS

A. Pretensioning Strand: ASTM A 416/A 416M, Grade 250 or Grade 270 uncoated, 7-wire or ASTM A 886/A 886M, Grade 270, indented, 7-wire, low-relaxation strand.

B. Unbonded Post-Tensioning Strand: ASTM A 416/A 416M, Grade 270, uncoated, 7-wire, low-relaxation strand.

1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.6 and sheath with polypropylene tendon sheathing complying with ACI 423.6. Include anchorage devices and coupler assemblies.

C. Post-Tensioning Bars: ASTM A 722, uncoated high-strength steel bar.

****ARCH****

2.5 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.

B. Supplementary Cementitious Materials:

1. **[[**Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.**]]**
2. **[[**Metakaolin Admixture: ASTM C 618, Class N.**]]**
3. **[[**Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.**]]**
4. **[[**Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.**]]**

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with **[[~~Class 5S~~]] [[~~Class 5M~~]] [[~~Class 4S~~]]** [**Class 4M**] **[<Insert other aggregate classes if applicable>]**. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.

a. Gradation: [**Uniformly graded**] [**Gap graded**] [**To match design reference sample**].

2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate unless otherwise approved by Architect.

D. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330, with absorption less than 11 percent.

E. **[[**Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.**]]**

F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

H. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

ARCH

1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M.

I. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

2.6 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.

B. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Plate: ASTM A 283/A 283M.

D. Malleable-Iron Castings: ASTM A 47/A 47M.

E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30.

F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.

G. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.

H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65.

I. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.

J. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.

ARCH

K. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M.

1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.

2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

****ARCH****

L. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 according to SSPC-PA 1.

M. Welding Electrodes: Comply with AWS standards.

N. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.7 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:

1. Design bearing pads per recommendations of PCI MNL 120. Maximum allowance compressive stress shall be as noted. Provide acceptable test data on pad bearing strength showing pad can support compressive stress 1.25 times the maximum allowable with no cracking, splitting, or delaminating.
2. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D 2240; minimum tensile strength 2250 psi, ASTM D 412.
3. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D 2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test 1 specimen for every 200 pads used in Project.
4. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D 2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
5. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to stainless- or mild-steel plate, of type required for in-service stress.

****ARCH****

2.8 [[THIN-BRICK UNITS AND ACCESSORIES]]

A. **[[**Thin-Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, [**not less than 1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] [**1 inch (25 mm)**] thick with a tolerance of plus or minus 1/16 inch (1.6 mm), and as follows:**]]**

1. **[[**Products: Subject to compliance with requirements, [**provide the following**] [**provide one of the following**] [**available products that may be incorporated into the Work include, but are not limited to, the following**]:**]]**

a. **[[**<**Insert, in separate subparagraphs, manufacturer's name; product name or designation**>.**]]**

2. **[[**Face Color and Texture: [**Match Architect's samples**] [**Medium brown, wire cut**] [**Full-range red, sand molded**] [**Gray, velour**].**]]**
3. **[[**Face Size: 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.**]]**
4. **[[**Face Size: 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.**]]**
5. **[[**Face Size: 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.**]]**
6. **[[**Face Size: 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.**]]**
7. **[[**Face Size: 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.**]]**
8. **[[**Face Size: <**Insert dimensions**>.**]]**
9. **[[**[**Where indicated to "match existing,"**]provide thin brick matching color, texture, and face size of existing adjacent brick work.**]]**

    a. **[[**<**Insert information on existing brick if known**>.**]]**

10. **[[**Face Size: 57 mm high by 190 mm long.**]]**
11. **[[**Face Size: 70 mm high by 190 mm long.**]]**
12. **[[**Face Size: 90 mm high by 190 mm long.**]]**
13. **[[**Face Size: 90 mm high by 290 mm long.**]]**
14. **[[**Face Size: <**Insert dimensions**>.**]]**
15. **[[**Special Shapes: Include corners, edge corners, and end edge corners.**]]**
16. **[[**Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute; ASTM C 67.**]]**
17. **[[**Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."**]]**
18. **[[**Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).**]]**
19. **[[**Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.**]]**

B. **[[**Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.**]]**

C. **[[**Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:**]]**

1. **[[**Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.**]]**
2. **[[**Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.**]]**
3. **[[**Colors: [**As indicated by manufacturer's designations**] [**Match Architect's samples**] [**As selected by Architect from manufacturer's full range**].**]]**

****ARCH****

2.9 [[STONE MATERIALS AND ACCESSORIES]]

A. **[[**Stone facing for precast structural concrete is specified in Division 04 Section "Exterior Stone Cladding."**]]**

B. **[[**Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.**]]**

1. **[[**Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.**]]**

C. **[[**Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 07 Section "Joint Sealants" and that is nonstaining to stone substrate.**]]**

D. **[[**Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.**]]**

1. **[[**Elastomeric Anchor Sleeve: 1/2 inch (13 mm) long; 60 Shore, Type A durometer hardness; ASTM D 2240.**]]**

E. **[[**Bond Breaker: [**Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick**] [**Polyethylene sheet, ASTM D 4397, 6 to 10 mils (0.15 to 0.25 mm) thick**].**]]**

****ARCH****

2.10 [[INSULATED FLAT WALL PANEL ACCESSORIES]]

A. **[[**Molded-Polystyrene Board Insulation: ASTM C 578, [**Type I, 0.90 lb/cu. ft. (15 kg/cu. m)**] [**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**] [**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**]; [**square**] [**ship-lap**] edges; with R-value of <**Insert value**> and thickness of <**Insert dimension**>.**]]**

B. **[[**Extruded-Polystyrene Board Insulation: ASTM C 578, [**Type IV, 1.60 lb/cu. ft. (26 kg/cu. m)**] [**Type X, 1.30 lb/cu. ft. (21 kg/cu. m)**] [**Type VI, 1.80 lb/cu. ft. (29 kg/cu. m)**]; [**square**] [**ship-lap**] edges; with R-value of <**Insert value**> and thickness of <**Insert dimension**>.**]]**

C. **[[**Polyisocyanurate Board Insulation: ASTM C 591, [**Type I, 1.8 lb/cu. ft. (29 kg/cu. m)**] [**Type IV, 2 lb/cu. ft. (32 kg/cu. m)**] [**Type II, 2.5 lb/cu. ft. (40 kg/cu. m)**] unfaced, with R-value of <**Insert value**> and thickness of <**Insert dimension**>.**]]**

D. **[[**Wythe Connectors: [**Glass-fiber connectors**] [**Vinyl-ester polymer connectors**] [**Polypropylene pin connectors**] [**Stainless-steel pin connectors**] [**Bent galvanized reinforcing bars**] [**Galvanized welded wire trusses**] [**Galvanized bent wire connectors**] [**Cylindrical metal sleeve anchors**] manufactured to connect wythes of precast concrete panels.**]]**

****ARCH****

2.11 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Limit use of fly ash to 25 percent replacement of portland cement by.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 116 when tested according to ASTM C 1218/C 1218M.

****ARCH****

D. Normal-Weight Concrete Mixtures: Proportion [**face mixtures**] [**face and backup mixtures**] [**full-depth mixture**] [**face and backup mixtures or full-depth mixtures, at fabricator's option**] by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi [**<Minimum>**].
2. Maximum Water-Cementitious Materials Ratio: 0.45. [**<0.40.>**]

****ARCH****

E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.

****ARCH****

F. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi [**<Minimum.>**]
2. Unit [**<Dry>**] Weight: Calculated equilibrium unit [**<dry>**] weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft., according to ASTM C 567.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

I. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

****ARCH****

2.12 [[MOLD FABRICATION]]

A. **[[**Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.**]]**

1. **[[**Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.**]]**

B. **[[**Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.**]]**

1. **[[**Form joints are not permitted on faces exposed to view in the finished work.**]]**
2. **[[**Edge and Corner Treatment: Uniformly [**chamfered**] [**radiused**].**]]**

****ARCH****

2.13 [[THIN-BRICK FACINGS]]

A. **[[**Place form-liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.**]]**

B. **[[**Securely place thin-brick units face down into form-liner pockets and place concrete backing mixture.**]]**

C. **[[**Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.**]]**

D. **[[**Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading pointing grout onto faces of thin-brick units. Remove excess pointing grout immediately to prevent staining of brick.**]]**

1. **[[**Tool joints to a [**slightly concave**] [**grapevine**] [**V-**]shape when pointing grout is thumbprint hard.**]]**

E. **[[**Clean faces and joints of brick facing.**]]**

****ARCH****

2.14 [[STONE FACINGS]]

A. **[[**Clean stone surfaces before placing in molds to remove soil, stains, and foreign materials. Use cleaning methods and materials recommended by stone supplier.**]]**

B. **[[**Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of 3/4 inch (19 mm) from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.**]]**

1. **[[**Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than 2 anchors per stone unit of less than 2 sq. ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area; for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. horizontally and vertically. Locate anchors a minimum of 6 inches (150 mm) from stone edge.**]]**

C. **[[**Fill anchor holes with [**sealant filler and install anchors**] [**epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone**].**]]**

1. **[[**Install polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.**]]**

2. **[[**Install 1/8-inch (3-mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.**]]**

2.15 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Architect's and PC Manufacturer’s approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcement to maintain at least 3/4-inch minimum coverage. Increase cover requirements according to ACI 318 when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
5. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

1. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

ARCH

5. **[[**Protect strand ends and anchorages with a minimum of 1-inch- thick, nonmetallic, nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.**]]**

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

ARCH

I. **[[**Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.**]]**

J. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.

ARCH

1. Place backup concrete mixture to ensure bond with face-mixture concrete.

K. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.

L. Comply with ACI 306.1 procedures for cold-weather concrete placement.

M. Comply with PCI MNL 116 procedures for hot-weather concrete placement.

N. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.

O. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

P. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

2.16 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.

****ARCH****

B. **[[**Brick-Faced Precast Structural Concrete Units: Restrict the following misalignments to 2 percent of number of bricks in a unit:**]]**

1. **[[**Alignment of Mortar Joints:**]]**

    a. **[[**Jog in Alignment: 1/8 inch (3 mm).**]]**
    b. **[[**Alignment with Panel Centerline: Plus or minus 1/8 inch (3 mm).**]]**

2. **[[**Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch (3 mm).**]]**
3. **[[**Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.**]]**
4. **[[**Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch (6 mm); minus 1/8 inch (3 mm).**]]**
5. **[[**Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.**]]**

****ARCH****

C. **[[**Stone Veneer-Faced Precast Structural Concrete Units:**]]**

1. **[[**Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch (6 mm).**]]**
2. **[[**Variation in Joint Width: 1/8 inch in 36 inches (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.**]]**
3. **[[**Variation in Plane between Adjacent Stone Units (Lipping): 1/16-inch (1.6-mm) difference between planes of adjacent units.**]]**

****ARCH****

2.17 [[COMMERCIAL FINISHES]]

A. **[[**Commercial Grade: Remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch (5 mm).**]]**

B. **[[**Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch (13 mm) caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch (6 mm) in width that occur more than once per 2 sq. in (1300 sq. mm). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch (3 mm).**]]**

C. **[[**Grade B Finish: Fill air pockets and holes larger than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch (3 mm) in width that occur more than once per 2 sq. in. (1300 sq. mm). Grind smooth form offsets or fins larger than 1/8 inch (3 mm). Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.**]]**

D. **[[**Grade A Finish: Fill surface blemishes with the exception of air holes 1/16 inch (1.6 mm) in width or smaller, and form marks where the surface deviation is less than 1/16 inch (1.6 mm). Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.**]]**

E. **[[**Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.**]]**

F. **[[**Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.**]]**

G. **[[**Apply roughened surface finish according to ACI 318 (ACI 318M) to precast concrete units that will receive concrete topping after installation.**]]**

****ARCH****

2.18 [[COMMERCIAL ARCHITECTURAL FINISHES]]

A. **[[**Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform, straight, and sharp. Finish exposed-face surfaces of precast concrete units to match approved [**design reference sample**] [**sample panels**] [**mockups**] and as follows:**]]**

1. **[[**Design Reference Sample: <**Insert description and identify fabricator and code number of sample**>.**]]**
2. **[[**PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.**]]**
3. **[[**Smooth-Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.**]]**
4. **[[**Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.**]]**
5. **[[**Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.**]]**
6. **[[**Exposed-Aggregate Finish: Use chemical-retarding agents applied to concrete molds and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.**]]**
7. **[[**Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.**]]**
8. **[[**Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.**]]**
9. **[[**Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.**]]**
10. **[[**Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.**]]**
11. **[[**Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.**]]**

ARCH

2.19 [<CLOSURE PANELS>]

A. **[<Provide [2"] [__] thick precast concrete closure panels to close off space between tee stems where indicated on the drawings]. Furnish for installation under Division 4>.**

ARCH

2.20 [<DOVETAIL ANCHORS>]

A. [<Provide continuous dovetail slots with filler strips cast into precast elements as required for connection of adjacent masonry construction. Dovetail slots prefabricated of 24 gauge galvanized steel, unless otherwise noted and shall accommodate 1" dovetail masonry anchors provided under Division 4.>]

2.21 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to provide the following:

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.

C. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, the Owner's testing agency will obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.

1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect.
2. Cores will be tested in an air-dry condition or, if units will be wet under service conditions, test cores after immersion in water in a wet condition.
3. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Test results will be made in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted without approval of the Architect.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units without written permission from the precast fabricator.

F. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.

3. Remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.

ARCH

H. Grouting: Install grout as specified in Section 036000 “Structural Grouting.”

I. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.

1. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.

ARCH

4. **[**Place grout end cap or dam in voids at ends of hollow-core slabs.**]**
5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

3.4 SHOP QUALITY CONTROL

A. Shop Welds: The Owners Testing Agency shall inspect a minimum of 10% of embedded plates and assemblies fabricated by the precaster. Embedded plates and assemblies to be used in precast products and loose plates and assemblies for the support of precast but installed at the job site shall be tested.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be visually inspected and nondestructive tested according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.

C. The Testing Agency shall visually inspect all field welds in connections of all precast units and all connections for the work of other trades welded to embed plates in precast units.

D. The Testing Agency shall inspect a minimum of 10% of the field welded connections of precast units by magnetic particle.

E. Grout Special Inspection Requirements: See 036000 “Structural Grouting”

F. Testing agency will report test results promptly and in writing to Contractor and Architect.

G. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

J. The Contractor shall submit periodic reports, prepared by a Professional Surveyor retained by the Contractor and registered in the state of the project, verifying conformance to erection tolerances specified herein to the Architect. Such reports shall be submitted within three working days after completion of each lift of erected material.

****ARCH****

3.6 REPAIRS

A. Repair precast structural concrete units if permitted by Architect.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

D. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

****ARCH****

3.7 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Decorative concrete masonry units.
3. Pre-faced concrete masonry units.
4. Hollow brick.
5. Mortar and grout.
6. Steel reinforcing bars.
7. Masonry joint reinforcement.
8. Miscellaneous masonry accessories.

B. Related Sections:
1. Section 042000 "Unit Masonry" for additional masonry requirements.
2. Section 055000 "Metal Fabrications" for furnishing steel lintels, shelf angles, anchor rods, embedded plates, and bearing plates for unit masonry.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Unit Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide reinforced unit masonry that develops indicated net-area compressive strengths at 28 days, as indicated on drawings.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified

requirements shall be done at Contractor's expense. Materials tested shall be the same in every way to the materials used to construct this project and shall be from the same lots or batches used for constructing this project.

1. Clay Masonry Unit Test: For each type of unit required, according to ASTM C 67 for compressive strength.
2. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:
   1. Reinforcing Steel: Detail bending and placement of reinforced unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls. Drawings shall include:

      a. 1/4” scale elevations of all walls with all openings and reinforcing shown.
      b. Top and bottom elevations of walls and bearing elevations of all elements supported.
      c. Size and location of all openings, pockets, embedments, and anchor bolts.
      d. Bar sizes, location and quantities of reinforcing steel.
      e. Location and arrangement of supporting and spacing devices.
      f. Bending and cutting schedules.
      g. All control joints, expansion joints and horizontal relief joints.
      h. All other framing and/or special conditions affecting the work.
      i. ~~Mechanical rebar splice locations.~~

1.7 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

   1. Masonry units.

      a. Include material test reports substantiating compliance with requirements.
      b. Include data and calculations establishing average net-area compressive strength of units.

   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Grout: Submit grout strength test data. Data shall be in conformance with the requirements for concrete mix designs per Division 3 section “Cast-in-place concrete”
      a. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
      b. For self-consolidating grout, include test reports for slump flow and visual stability index (VSI) as determined by ASTM C1611

C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and

resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

1.8 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 latest edition unless modified by requirements in the Contract Documents.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as required to meet the specified prism strength, but in no case shall units be less than 1900 psi.
2. Density Classification: Lightweight unless otherwise indicated.

2.2 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure prefabricated lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.3 BRICK

A. Hollow Brick: ASTM C 652, Grade SW, Class H60V (void areas between 40 and 60 percent of gross cross-sectional area).

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as required to meet the specified prism strength, but in no case shall units be less than 3500 psi.

2.4 MORTAR AND GROUT MATERIALS

A. Blended Hydraulic Cement: ASTM C 595 Type IL, Portland-limestone cement.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

G. Additives: None permitted, except as specified herein. Specifically, do not lower freezing point of mortar or grout by use of calcium chloride or other antifreeze agents.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: As indicated on drawings
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry: Provide one of the following:

1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches wide, plus 1 side rod at each wythe of masonry 4 inches wide or less.
2. Tab type, ladder design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
3. Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.6 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed steel bolts complying with ASTM F1554 grade 36, or ASTM A307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.7 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. For reinforced masonry, use portland cement-lime mortar.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Reinforced Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Unless acceptable, do not hand mix mortar. Maintain workability of mortar by remixing or retempering. Discard mortar which has begun to stiffen or is not used within 2-½ hours after initial mixing.

D. Grout for Reinforced Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 7 in TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Grout shall attain a minimum compressive strength of 2000 psi at 28 days when tested in accordance with C1019.
3. Except for self-consolidating grout, mix and proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated.
4. Provide grout with a slump of 8 to 11 inches for grout heights less than 5 feet 4 inches, or 10 to 11 inches for grout lift heights greater than 5 feet 4 inches as measured according to ASTM C 143/C 143M, unless self-consolidating grout is used.
5. Self consolidating grout, if used, shall comply with the material requirements of ASTM C476; have a slump flow of 24 to 30 in as determined by ASTM C1611/C1611M; and has a Visual Stability Index (VSI) less than or equal to 1 as determined in accordance with ASTM C1611/C1611M, Appendix X.1.
6. Proportioning of self-consolidating grout at the project site is not permitted. Do not add water at the project site except in accordance with the self-consolidating grout manufacturer's recommendations.
7. Do not use admixtures unless acceptable. Field additional of admixtures is not permitted in self-consolidating grout.

PART 3 - EXECUTION

3.1 LAYING MASONRY WALLS

A. Bond Pattern: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

B. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

C. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.2 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar each side of grouted cells.

3.3 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.4 CONTROL AND EXPANSION JOINTS

A. General: Install control joint materials in reinforced unit masonry as masonry progresses, as indicated on drawings.

3.5 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

3.6 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6, latest edition.
1. Support reinforcement to prevent displacement caused by construction loads or by placement of grout or mortar, beyond the allowable tolerances.
2. Completely embed reinforcing bars in grout.
3. Maintain clear distance between reinforcing bars and the interior of masonry unit or formed surface of at least 1/4 inch for fine grout and 1/2 inch for coarse grout, except where cross webs of hollow units are used as supports for horizontal reinforcement.
4. Place reinforcing bars maintaining the following minimum cover:

a. Masonry face exposed to earth or weather: 2 inches for bars larger than No. 5; 1½ inches for No. 5 bars or smaller.
b. Masonry not exposed to earth or weather: 1½ inches.

5. Maintain minimum clear distance between parallel bars of the nominal bar size or 1 inch, whichever is greater.
6. In columns and pilasters, maintain minimum clear distance between vertical bars of one and one-half times the nominal bar size or 1½ inches, whichever is greater.
7. Splice only where indicated on the Project Drawings, unless otherwise acceptable
8. Unless accepted by the Architect/Engineer, do not bend reinforcement after it is embedded in grout or mortar.
9. Noncontact lap splices: Position bars spliced by noncontact lap splice no farther apart transversely than one-fifth the specified length of lap nor more than 8 inches.
10. Joint reinforcement

    a. Place joint reinforcement so that longitudinal wires are embedded in mortar with a minimum cover of 1/2 inch when not exposed to weather or earth; or 5/8 inch when exposed to weather or earth.
    b. Provide minimum 6-inch lap splices for joint reinforcement.
    c. Ensure that all ends of longitudinal wires of joint reinforcement at laps are embedded in mortar or grout.

11. Placement Tolerances

    a. Place reinforcing bars in walls and flexural elements within a tolerance of 1/2 inch.
    b. Place vertical bars within:

        1) 2 inches of the required location along the length of the wall when the wall segment length exceeds 24 inches.
        2) 1 inch of the required location along the length of the wall when the wall segment length does not exceed 24 inches.

    c. If it is necessary to move bars more than one bar diameter or a distance exceeding the tolerance stated above to avoid interference with other reinforcing steel, conduits, or embedded items, notify the Architect/Engineer for acceptance of the resulting arrangement of bars.
    d. Foundation dowels that interfere with unit webs are permitted to be bent to a maximum of 1 inch horizontally for every 6 inches of vertical height.

C. Cleanouts: Provide cleanouts in the bottom course of masonry for each grout pour when the grout pour height exceeds 5 feet 4 inches.

1. Construct cleanouts so that the space to be grouted can be cleaned and inspected. In solid grouted masonry, space cleanouts horizontally a maximum of 32 inches on center.
2. Construct cleanouts with an opening of sufficient size to permit removal of debris. The minimum opening dimension shall be 3 inches.
3. After cleaning, close cleanouts with closures braced to resist grout pressure.

D. Grout Placement

1. Placing time: Place grout within 1-1/2 hours from introducing water in the mixture and prior to initial set.

a. Discard site-mixed grout that does not meet the specified slump without adding water after initial mixing.
b. For ready-mixed grout:

1) Addition of water is permitted at the time of discharge to adjust slump.
2) Discard ready-mixed grout that does not meet the specified slump without adding water, other than the water that was added at the time of discharge. The time limitation is waived as long as the ready-mixed grout meets the specified slump.

2. Confinement: Confine grout to the areas indicated on the Project Drawings. Use material to confine grout that permits bond between masonry units and mortar.
3. Grout pour height:

a. Definition: The total height of masonry to be grouted prior to erection of additional masonry. A grout pour consists of one or more grout lifts.
b. Do not exceed the maximum grout pour height given in TMS 602/ACI 530.1/ASCE 6, Table 7.

4. Grout lift height:

a. Definition: An increment of grout height within a total grout pour. A grout pour consists of one or more grout lifts.
b. For grout except self-consolidating grout:

1) Where the following conditions are met, place grout in lifts not exceeding 12 feet 8 inches.

a) The masonry has cured for at least 4 hours.
b) The grout slump is maintained between 10 and 11 inches.
c) No intermediate reinforced bond beams are placed between the top and the bottom of the pour height.

2) When there are intermediate bond beams within the grout pour, limit the grout lift height to the bottom of the lowest bond beam that is more than 5 feet 4 inches above the bottom of the lift, but do not exceed a grout lift height of 12 feet 8 inches.
3) When the conditions above are not met, place grout in lifts not exceeding 5 feet 4 inches.

5. For self-consolidating grout:

a. When placed in masonry that has cured for at least 4 hours, place in lifts not exceeding the grout pour height.
b. When placed in masonry that has not cured for at least 4 hours, place in lifts not exceeding 5 feet 4 inches.

E. Consolidation

1. Consolidate grout at the time of placement.

a. Consolidate grout pours 12 inches or less in height by mechanical vibration or by puddling.
b. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.
c. Consolidation or reconsolidation is not required for self-consolidating grout.

F. Grout key: When grouting, form grout keys between grout pours. Form grout keys between grout lifts when the first lift is permitted to set prior to placement of the subsequent lift

1. Form a grout key by terminating the grout a minimum of 1½ inches below a mortar joint.
2. Do not form grout keys within beams.
3. At beams or lintels laid with closed bottom units, terminate the grout pour at the bottom of the beam or lintel without forming a grout key.

3.7 FIELD QUALITY CONTROL

A. As indicated on drawings

END OF SECTION 042010

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish labor, tools, scaffolding, and required equipment, and materials for masonry construction specified and required to provide high quality masonry workmanship.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Qualifications of Workmen:
   1. For actual cutting and placing of masonry units, use skilled journeyman masons thoroughly experienced with materials and methods specified and thoroughly familiar with design requirements.
   2. Have one skilled journeyman mason present at all times during execution of work of this Section who shall personally direct and execute this portion of the Work.

PART 2 - PRODUCTS

2.01 THIN BRICK MATERIALS

A. ST-01: Thin Brick Veneer
Manufacturer: General Shale Brick
Product: Thin Brick
Color: Custom Blend – 20% Mesquite, 20% Old Georgetown, 30% Brimstone, 30% Thundercloud
Size: 2”x8”

B. ST-02: Stone Block
Manufacturer: Antique Brick & Block
Product: Timber Creek Cut Sandstone
Thickness: TBD
Note: Refer to architectural drawings for sizing information

2.02 CEMENT BOARD

A. Refer to Section 09 2500.

2.03 INSTALLATION MATERIALS AND ACCESSORIES

A. Air and Water Barrier Membrane: LATICRETE® Air & Water Barrier , or approved equal.

B. Epoxy Waterproofing Flashing Mortar: LATAPOXY® Waterproof Flashing Mortar , or approved equal.

C. Latex-Portland Cement Mortar for leveling beds and scratch/plaster coats: LATICRETE Premium Mortar Bed, or approved equal.

D. Latex Portland Cement Mortar: LATICRETE Hi Bond Masonry Veneer Mortar , or approved equal.

E. Expansion and Control Joint Sealant: LATICRETE Latasil™ , or approved equal.

PART 3 - EXECUTION

3.01 LAYING VENEER BRICK

A. Lay facing with full mortar joints and back parged or slushed with mortar to obtain a solid masonry wall. Tool joints concave.

3.02 BUILT-IN ITEMS

A. Build in wood blocks, strips, wedges, frames, loose lintels, miscellaneous iron and other items furnished by other subcontractors and which may be required for properly securing their work.

3.03 CLEANING PREMISES

A. Mason Contractor: Remove rubbish and building materials left over from operations under his charge, whenever directed by General Constructor. Premises must be left clear and clean. When buildings are completed, completely remove mortar droppings.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Sections:

1. Section 014000 "Quality Requirements" for independent testing agency procedures and administrative requirements.

ARCH

2. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
3. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
4. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications including steel lintels and shelf angles not attached to structural-steel frame and other metal items not defined as structural steel.

ARCH

5. Section 055100 "Metal Stairs."
6. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for surface-preparation and priming requirements.
7. Section 133419 "Metal Building Systems" for structural steel.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 2 inches.
2. Welded built-up members with plates thicker than 2 inches.
3. Shapes included in ASTM A 6/4 6M with flanges thicker than 1-1/2 inches included in the Seismic-Load-Resisting System.

4. Connection plates and column base plates thicker than 2 inches included in the Seismic-Load-Resisting System.

1.4 PERFORMANCE REQUIREMENTS

A. Connections:
   1. Provide connections as shown or noted on Drawings. Design of connections not shown or noted shall be provided by Structural Engineer-of-Record upon request.
   2. Alternate connections designed by the contractors registered design professional may be substituted by the Contractor, subject to Structural Engineer-of-Record approval. Proposed changes to connections shall be submitted as a substitution request in advance of the submittal of shop drawings for conceptual approval of Structural Engineer-of-Record. Connections shall be designed for loads indicated on drawings or provided by Structural Engineer-of-Record. Loads indicated are developed using Load and Resistance Factor Design (LRFD) load combinations unless noted otherwise. One set of calculations for all alternate connections signed and sealed by a qualified engineer shall be submitted with or in advance of applicable shop drawings. Contractor shall submit alternate connections to the AHJ in accordance with IBC section [A]107.3.4.1 Deferred Submittal and [A]107.4 Amended Construction Documents.

B. Construction: Refer to the Drawings for description of lateral load resisting system.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop and Erection Drawings: Show location, fabrication, and assembly of structural-steel components.

   1. Location of each piece or detail within the structure.
   2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   3. Include embedment piece and setting drawings.
   4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   6. Identify members and connections of the seismic-load-resisting system.
   7. Indicate locations and dimensions of protected zones.
   8. Identify demand critical welds.

****ARCH****

   9. Drawings submitted in multiple packages shall contain individual submittals complete with all applicable erection drawings, details, and piece drawings.
   10. Reproduction of Contract Documents is not permitted.
   11. Provide schedule for submittal of shop and erection drawings.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing:

D. Charpy V-Notch testing results for heavy sections and weld metal when required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and fabricator.

B. Welding certificates.

****ARCH****

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties and steel mill of origin.
   1. For structural steel products that are manufactured in a different facility than where the raw material is produced, the mill test report or separate letter included with the report shall clearly indicated the location of both facilities.
   2. If structural steel elements are sourced from multiple facilities, mill test reports shall be provided for each facility with a statement outlining the applicability of each report submitted.

E. Product Test Reports: For the following if present on project:

   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength bolt-nut-washer assemblies.
   4. Shear stud connectors.
   5. Shop primers.
   6. Nonshrink grout.

F. Fabricator qualifications: Provide written documentation from the fabricator summarizing their commitment to sustainable practices as outlined in Part 2 – Products.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

****ARCH****

C. Field Painting Applicators: Qualified according to SSPC-QP1, “Standard Procedure for Evaluating Qualifications of Painting Contractors “Field Application to Complex Structures”.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

   1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

   1. AISC 303 -2016 as amended below:

a. Section 3.2: Replace entire section with the following: “Requirements for structural steel including quantities, sizes, locations, arrangement, and details shall be shown or noted in the overall Contract Drawing package. Fabricator is responsible for incorporating all such information from structural, architectural, mechanical, and electrical drawings, as well as those of other disciplines.”
b. Section 3.5: Remove all text after first sentence.
c. Section 3.6: Replace entire section with the following: “When the fast-track project delivery system is selected, release of structural drawings shall constitute release for construction only if specifically noted as such on the drawing. Drawing indicated “preliminary” or “not for construction” shall not be used for detailing or construction except where the risk of any cost or delay associated with subsequent revisions to Contract Documents is accepted by the Owner, Contractor or Fabricator.”
d. Section 4.4: Revise second sentence to read the following: “The shop and erection drawings shall be returned in accordance with the schedule defined in Division 1 of the project Specification. In the absence of such schedule, the Owner’s Designated Representative for Design shall return submittals within 14 calendar days of receipt from the Owner’s Designated Representative for Construction.”

2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

F. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.9 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

****ARCH****

A. Supply structural steel materials produced and manufactured in the United States of America or Canada for all elements listed in this section and as required in the construction documents.

B. W-Shapes: As indicated on Drawings.

C. Channels, Angles Shapes: As indicated on Drawings.

D. Plate and Bar: As indicated on Drawings.

E. Cold-Formed Hollow Structural Sections: As indicated on Drawings.

F. Steel Pipe: As indicated on Drawings.

1. Weight Class: as indicated on Drawings.
2. Finish: Black except where indicated to be galvanized.

G. Welding Electrodes: Comply with AWS requirements, 70 Series

1. Conform to Charpy V-Notch test requirements of AISC 360.
2. Conform to Charpy V-Notch test requirements of AISC 341 for components included in the Seismic-Load-Resisting System.

H. Heavy Sections:

1. Conform to Charpy V-Notch test requirements of AISC 360.
2. Conform to Charpy V-Notch test requirements of AISC 341 for components included in the Seismic-Load-Resisting System.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. Use Tension-Control, High-Strength Bolt-Nut-Washer Assemblies whenever possible unless indicated otherwise.

B. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Group 120, Type 1 A325 or F1852. Heavy-hex steel structural bolts; ASTM A 563, Type 1 Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; or Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers all with plain finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain

D. Steel Headed Stud Anchors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable

1. Configuration: Straight.
2. Nuts: ASTM A 563 heavy-hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436, Type 1, hardened carbon steel.

5. Finish: Plain.

F. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: Plain.

G. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain.

H. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

K. Deformed Anchor Studs (DAS) / Deformed Bar Anchors (DBA): Made from ASTM A 108 low carbon steel, cold worked and deformed per ASTM A 1064. Minimum yield stress = 60 ksi; minimum tensile strength = 80 ksi.

L. Rebar: Rebar used for welding shall meet the requirements of ASTM A-706. Minimum bend diameters per ACI 318.

M. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Mating Surfaces: PTFE and mirror-finished stainless steel.
3. Coefficient of Friction: Not more than 0.06.
4. Design Load: Not less than 2,000 psi.
5. Total Movement Capability: 2 inches.
6. Applicable Temperature range: 0°F to 100°F.

N. Expansion Anchors, Screw Anchors, and Adhesive Anchors: Size and Manufacturer as indicated on Drawings. Complete assemblies with required rods, nuts, washers, and adhesive system as applicable.

Installed in accordance with Manufacturer's installation instructions. Current ICC approval and published ICC Research Report required.

1. Finish for use in conditioned environments free from potential moisture (interior): Plain or in accordance with Manufacturer's standard.
2. Finish for use in exposed or potentially wet environments and for attachment of exterior cladding materials: Galvanized in conformance with ASTM A 153 or stainless steel, Series 316.
3. Finish for use in exposed to ocean or waterfront type 316 stainless steel.

****ARCH****

2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: Where steel is to be field painted, provide fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

C. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.4 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi. Required where grout is exposed to view or weathering.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations, if applicable.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces. Do not enlarge bolt holes by burning.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

ARCH

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning or SSPC-SP 3, "Power Tool Cleaning."

F. Steel Headed Stud Anchors and Deformed Anchor Studs / Deformed Bar Anchors: Prepare steel surfaces as recommended by manufacturer of anchors. Use automatic end welding of anchors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, thermal cut, or punch holes perpendicular to steel surfaces.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

H. Splices: Splicing of members to obtain required lengths is not permitted without prior approval of structural Engineer-of-Record unless indicated on the Drawings.

I. Substitutions: Where exact sizes and weights indicated on Drawings are not readily available, secure approval of alternate sizes from Structural Engineer-of Record in time to prevent project delay.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

ARCH

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded, including top flange of beams to receive steel headed stud anchors.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Surfaces not otherwise indicated to be painted that are not exposed to view or weather in the final condition.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to either of the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection.

****ARCH****

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes in closed sections (HSS or Pipe) that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels and shelf angles located in exterior walls.

2.10

~~2.9~~ SOURCE QUALITY CONTROL

2.9 Weathering Steel: (grade A325, Type 3).

A. Testing and Inspection: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Coordinate installation of non-structural steel items that load the temporarily supported steel frame such that temporary supports are adequate to resist all imposed loads.

2. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3. Do not apply permanent loading other than the weight to supported concrete slab-on-deck assemblies to composite beams and girders until concrete has achieve 75 percent of its design strength without prior approval of structural Engineer-of-Record.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate where indicated on Drawings.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Clean and moisten surfaces to receive grout. Immediately remove any remaining free water. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature of 70° F when structure is completed and in service.

E. Splice members only where indicated.

1. Fasten splices in compression after bearing surface have been brought into contact. Close all gaps greater than 1/16” by driving non-tapered mild steel shims full depth of bearing surface along full length of gap.

F. Do not use thermal cutting during erection unless approved by Structural Engineer-of-Record. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Steel Headed Stud Anchors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated on Drawings, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

****ARCH****

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting."

END OF SECTION 0512000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof deck.
2. Composite floor deck.
3. Noncomposite form deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

****ARCH****

4. Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
5. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

ARCH

B. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

ARCH

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Recycled Content of Steel Products: Provide products with an average recycled content of steel products not less than as indicated on the structural drawings.

D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. New Millennium Building Systems, LLC.
2. Nucor Corp.; Vulcraft Group.
3. Verco Manufacturing Co.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Deck," and with the following:

ARCH

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G90 zinc coating, shop primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at interior locations.

    a. Color: Manufacturer's standard [Gray] [White] [Gray top surface with white underside].

2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G90 zinc coating. Use at exterior locations not indicated to be painted and exposed to view.
3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G90 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.

    a. Color: Manufacturer's standard [Gray] [White] [Gray top surface with white underside].
4. Span Condition: As indicated on the structural drawings.
5. Side Laps: Overlapped.

****ARCH****

2.3 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. New Millennium Building Systems, LLC.
2. Nucor Corp.; Vulcraft Group.
3. Verco Manufacturing Co.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Steel Deck," with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard [**gray**] [**or**] [**white**] baked-on, rust-inhibitive primer. May be used at interior locations.
2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G60 zinc coating. May be used at interior or exterior locations not indicated to be painted and exposed to view.
3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard [**gray**] [**white**] baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.
4. Span Condition: As indicated on the structural drawings.

2.4 NONCOMPOSITE FORM DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. New Millennium Building Systems, LLC.
2. Nucor Corp.; Vulcraft Group.

3. Verco Manufacturing Co.

B. Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Steel Deck," with the minimum section properties indicated, and with the following:

****ARCH****

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G60 zinc coating typical. Use G90 where exposed to moisture.
2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated on the structural drawings, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at locations indicated to be painted and exposed to view.

   a. Color: Manufacturer's standard [**Gray**] [**White**] [**Gray top surface with white underside**].
3. Span Condition: As indicated on the structural drawings
4. Side Laps: Overlapped

2.5 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

****ARCH****

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated but not less than recommended by SDI for overhang and slab depth.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

****ARCH****

H. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

****ARCH****

I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and [**level**] [**sloped**] recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.

****ARCH****

J. Galvanizing Repair Paint: ASTM A 780.

K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. When steel headed stud anchors are to be welded through metal deck and/or corrugated metal forming, the top flange of beams to receive such anchors shall be unpainted and free of debris prior to installation of the deck and/or forming.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations. Obtain prior written approval from Structural Engineer-of-Record before installing shoring.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

1. Refer to Drawings for opening sizes requiring reinforcement and typical reinforcement options.
2. Miscellaneous openings not shown on the Drawings such as those required for vents, risers, conduits, etc. shall be cut and reinforced if necessary, by the trade requiring the opening.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck with prior written approval of Structural Engineer-of-Record. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels as indicated on the structural drawings. Provide weld washer at each location where uncoated deck of thickness 0.028 inches or less is being fastened to supporting members by welding.

B. End Bearing: Install deck ends over supporting frame with a minimum end bearing length as indicated on the structural drawings, with end joints as follows:

1. End Joints: Lapped as indicated on the structural drawings.

****ARCH****

C. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and [**weld**] [**mechanically fasten**] flanges to top of deck. Space [**welds**] [**mechanical fasteners**] not more than 12 inches (305 mm) apart with at least one [**weld**] [**fastener**] at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and [**weld**] [**or**] [**mechanically fasten**].

****ARCH****

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

****ARCH****

F. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Section <**Insert Section number**> "<**Insert title of applicable roofing Section**>."

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: As indicated on the structural drawings, nominal.
2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart. Steel headed stud anchors may be substituted for welds one for one in meeting spacing requirements.

3. Weld Washers: Install weld washers at each weld location when the minimum uncoated steel thickness is less than 0.028 inches.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows unless otherwise indicated:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing as indicated on the structural drawings, with end joints as follows:

1. End Joints: As indicated on the structural drawings

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Install piercing hanger tabs at minimum spacing indicated in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

G. Fastening Corrugated Metal Forming: Secure to supporting member with 1/2 inch minimum diameter fusion welds made through 0.0747 inch welding washers. Minimum weld requirements as follows:
1. End Laps: In valley of side laps and at center of sheet.
2. Intermediate Supports: In valley of side lap on every other support and in valley of center corrugation on the remaining supports (to form an X pattern).
3. Exterior Edges: 12” on center.
4. Minimum Number of Welds Per 100 square foot of Deck Area:
   a. 0.0164 inches thick and thinner – 25
   b. Thicker than 0.0164 inches – 15

H. Steel headed stud anchors shall be field welded to the structural members only after all steel framing, deck and/or forms are in place and shored when required. Deck and/or forming shall be installed such that the bottom rib plate is in continuous contact with the surface to receive anchors.

I. Steel Headed Stud Anchor Capacity: Number of steel headed stud anchors indicated on Drawings is based on the allowable capacity for anchors in normal weight or light weight concrete as listed in AISC 360 for the composite deck specified. If additional anchors are required due to decreases in anchor capacity for the type of deck and stud placement supplied, such additional anchors shall be provided at no additional cost to the Owner.

J. Steel Headed Stud Anchor Installation:
1. Install anchors in accordance with Manufacturer’s instructions. Use only personnel and equipment authorized by the Manufacturer.
2. Use through-deck anchor welding where deck material thickness permits proper weld fusion to develop required anchor capacity. Provide adequate test results to verify feasibility of through-deck welding for the particular anchor sizes and deck thicknesses involved.
3. If through-deck anchor welding is not feasible, install anchors through pre-punched holes in deck. Provide pre-punched holes only where required for anchor installation and keep hole oversize to minimum required to develop a proper weld.

K. At the beginning of each shift of work, and after each time welding equipment has been moved, two test anchors shall be installed and bent to 45 degrees by the Contractor. If failure occurs, adjust equipment and repeat test. Two consecutive test studs shall be welded and found satisfactory before production for that shift begins or is resumed.

3.5 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on the structural drawings.

3.6 PROTECTION

A. Galvanizing Repairs: Where deck is exposed to weather or moisture, prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

1. Do not use deck units for storage or as a working platform until permanently secured in position.
2. Contractor shall assure that completed deck is not damaged by use as a runaway, storage of materials or subsequent work.
3. Contractor shall assure that construction loads are not allowed which exceed the safe carrying capacity of the deck.

END OF SECTION 053100

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior load-bearing wall framing.
2. Interior load-bearing wall framing.
3. Exterior non-load-bearing wall framing.
4. Floor joist framing.
5. Roof trusses.
6. Roof rafter framing.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
2. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
3. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated in drawings.

2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

   a. Exterior Load-Bearing Wall Framing: Horizontal deflection of 1/240 of the wall height.
   b. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
   c. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.

3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate deflection of primary building structure as indicated on the drawings.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

1.4 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. Shop Drawings: Provide ¼" = 1'-0" scale elevations of all walls and plans of all soffits comprised of cold-formed metal framing. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. For projects where sustainability goals are a project/contract requirement per owner approval or direction, sustainability submittal requirements should be moved to Action Submittal section of specifications. Edit sustainability submittal section and relocate certain requirements to Action Submittals as appropriate for the project.

B. Welding certificates.

C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
1. Vertical deflection clips.
2. Horizontal drift deflection clips
3. Stiff Clips

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Special Inspections and Testing: Special inspections and tests indicated on the construction documents and indicated within this specification are minimum requirements. The cold-formed metal framing construction documents shall include the minimum testing and inspection requirements as indicated on the construction documents and shall include additional testing and inspections that the engineer of the cold-formed metal framing engineer requires. All special inspections and tests (minimum design

requirements on construction documents and those specified by cold-formed metal framing engineer) shall be paid for by the Owner.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

E. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

F. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

G. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
2. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Studco.
2. AllSteel Products, Inc.
3. California Expanded Metal Products Company.
4. Clark Steel Framing.
5. Consolidated Fabricators Corp.; Building Products Division.
6. Craco Metals Manufacturing, LLC.
7. Custom Stud, Inc.
8. Dale/Incor.
9. Design Shapes in Steel.
10. Dietrich Metal Framing; a Worthington Industries Company.
11. Formetal Co. Inc. (The).
12. Innovative Steel Systems.
13. MarinoWare; a division of Ware Industries.
14. Quail Run Building Materials, Inc.

15. SCAFCO Corporation.
16. Southeastern Stud & Components, Inc.
17. Steel Construction Systems.
18. Steeler, Inc.
19. Super Stud Building Products, Inc.
20. United Metal Products, Inc.

2.2 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: [**ST33H (ST230H)**] [**<u><, 33 ksi for studs 18 gauge and lighter.></u>**] [**ST50H (ST340H)**] **[[~~As required by structural performance~~]]** <**Insert grade**>.
2. Coating: [**G60 (Z180), [[~~A60 (ZF180), AZ50 (AZ150), or GF30 (ZGF90)~~] [~~G90 (Z275)~~]] or equivalent**].

B. Steel Sheet for [**Vertical Deflection**] [**<u>Stiff</u>**>][**Drift**] Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: [**50 (340), Class 1 or 2**] [**As required by structural performance**].
2. Coating: G90 (Z275).
3. Gauge: 14 gauge minimum.

2.3 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers, knee braces, and girts.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.4 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 55, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Powder-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.5 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, nonleaching.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.6 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:

1. Maximum Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   1. Connect vertical deflection clips to bypassing and infill studs and anchor to building structure.
   2. Connect drift clips to cold formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

   1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish and install miscellaneous metal items required and specified. Provide miscellaneous bolts, anchors, supports, braces, and connections necessary for completion of Work.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.
   1. Submit Shop Drawings on miscellaneous metal items for review by Architect, prior to fabrication. Include type, grade, class of metal and sizes, details of fabrication, methods of assembling, connections to supporting construction, reinforcement, and location of hardware.
      a. Contract Document electronic files (including all drawings, specifications, addenda and supplemental information) will not be made available to Bidders or Sub-bidders before the award of a Contract. After the award of the Contract, the General Contractor may make request for release of electronic document files.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. Specifications for the Design, Fabrication and Erection of Structural Steel for Building

B. American National Standards Institute (ANSI):
   1. ANSI A14.3, "Ladders, Fixed, Safety Requirements."

C. American Society for Testing and Materials (ASTM):
   1. ASTM A36, "Structural Steel."
   2. ASTM A53, "Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe."
   3. ASTM A123, "Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products."
   4. ASTM A153, "Zinc Coating (Hot-Dip) on Iron and Steel Hardware."
   5. ASTM A307, "Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength."

6. ASTM A446, "Specification for Sheet Steel, Zinc-Coated by the Hot-Dip Process."
7. ASTM A500, "Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes."
8. ASTM A568, "Specification for General Requirements for Steel, Carbon and High-Strength Low Alloy Hot-Rolled Sheet and Cold Rolled Sheet."
9. ASTM A627, "Specification for Homogeneous Tool-Resisting Steel Bars for Security Applications.
10. ASTM A780, "Practice for Repair of Damaged Hot-Dipped Galvanized Coatings."
11. ASTM B221, "Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube."

D. American Welding Society (AWS):
1. AWS D1.1 - Structural Welding Code.

E. Steel Structures Painting Council Specification (SSPC):
1. Steel Structures Painting Manual.

1.05 QUALITY ASSURANCE

A. Qualifications of Welders: Use certified welders and the shielded arc process for welding performed in connection with work of this Section.

B. Codes and Standards: In addition to complying with pertinent codes and regulations, comply with:
1. "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.
2. "Code for Welding in Building Construction" of the American Welding Society.

C. Conflicting Requirements: In event of conflict between pertinent codes and regulations, requirements of the referenced standards, and these specifications, provisions of more stringent govern.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel plates, angles, and other structural shapes shall conform to ASTM A36.

B. Steel pipe shall conform to ASTM A53, Grade B, Schedule 40.

C. Galvanized steel pipe and tube shall conform to ASTM A53.

D. Steel Tubing shall conform to ASTM A500.

E. Sheet Steel, Galvanized: ASTM A446.

F. Sheet and Strip Steel, Hot Rolled: ASTM A568.

G. Stainless-Steel Bars and Shapes: ASTM A 276, [**Type 304**] [**Type 316L**].

H. Welding Materials: AWS D1.1; type required for materials being welded.

I. Anchors
   1. Threaded Type Concrete Inserts: Galvanized malleable iron or cast steel capable of receiving 3/4 inch diameter machine bolts.
   2. Slotted Type Concrete Inserts: Welded box type fabricated with minimum 1/8 inch thick galvanized pressed steel plate with slot to receive 3/4 inch diameter square head bolt and knockout cover.
   3. Expansion Shield for Masonry Anchorage: FS FF-2-325.
   4. Toggle Bolts: FS FF-B-588.

J. Adhesive Anchors:
   1. In Unreinforced Masonry Units ICC-ES AC60. Acceptable adhesives are Hilti HIT-HY70 (ICC-ESR-3342) Simpson SET (ICC-ES ESR-1772) Simpson AT (ICC-ES ESR-1958).
      a. Steel anchor element shall be Hilti HAS-E or ASTM F1554 Grade 36 continuously threaded rod.
   2. In Hollow Concrete Masonry Units: ICGES AC58. Acceptable adhesives are Hilti HIT-HY 70 (ICC-ESR-2682), Simpson SET, Simpson AT, or approved equal.
      a. Plastic mesh screen tube per manufacturer recommendations required.
   3. In Solid Grouted Masonry Units: ICC-ES AC58. Acceptable adhesives are Hilti HIT-HY 70 (ICC-ESR-3342), Simpson SET-XP (IAPMO UES-ER-265), or Simpson AT-XP (IAPMO UES-ER-281).
      a. Steel anchor element shall be Hilti HASE, ASTM F1554 Grade 36, or ASTM A193, Grade B6, B8 or B8M continuously threaded rods.
   4. In Concrete: ICC-ES AC308. Acceptable anchors are Hilti HIT-HY 200 SAFESet fast cure (ICC-ESR-3187), Hilti HIT-RE 500-SD slow cure (ICC-ESR-2322), Simpson SET-XP (ICC-ESR-2508), Simpson AT-XP (IAPMO UES-ER-263), or approved equal.
      a. Steel anchor element shall be Hilti HASE, STM F1554 Grade 36, or ASTM A193, Grade B6, B8, or B8M continuously threaded rod.

K. Fasteners General:
   1. Provide **Type 304** stainless-steel fasteners at stainless steel and aluminum fabrications.
   2. Bolts, Nuts and Washers for Exterior Locations: ASTM A307, galvanized in accordance with ASTM A153.
   3. Bolts, Nuts and Washers for Interior Locations: ASTM A307, Grade A, regular hexagon head.
   4. Bolts, Round Head: ANSI B-18.5
   5. Wood Screws, Flat Head Carbon Steel: ANSI B-18.6.1.
   6. Plain Washers, Helical Spring Type Carbon Steel: FS FF-W-84.

L. Column Anchor Rods: ASTM F1554, Grade 36 minimum, but See Schedule on drawings for other specified Grades.

2.02 FABRICATION

A. Fabricate steel items according to approved shop drawings and to applicable portions of AISC Specifications. Conceal welds where possible; grind exposed welds smooth and flush with adjacent finished surface. Ease exposed edges to small uniform radius.

B. Pre-assemble products in shop to greatest extent possible. Disassemble units to extent necessary for shipping and handling. Clearly mark units for re-assemble and installation.

C. For exposed to view fabrications, use materials which are smooth and free of surface blemishes including pitting, seams marks, roller marks, roller trade names and roughness. Remove blemishes by grinding or by welding and grinding, prior to cleaning, treating and application of surface finishes including zinc coating.

D. Fabricate items with joints tightly fitted and secured.

E. Fit and shop assemble in largest practical sections for delivery to Project site.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of structure, except where specifically noted otherwise.

G. Make exposed joints butt tight, flush and hairline.

H. Fabricate anchorage and related components of same material and finish as metal fabrication, unless indicated otherwise.

2.03 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 sections.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.04 LOOSE STEEL LINTELS

A. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

B. Weld adjoining members together to form a single unit where indicated.

C. Size loose lintels for equal bearing of one inch per foot of clear span but not less than 8 inches bearing at each side of openings, unless otherwise indicated.

D. All steel lintels exposed to weather shall be galvanized.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
   1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
      a. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inch x 8 inches long.

2.06 SHELF AND RELIEVING ANGLES

A. Fabricate shelf and relieving angles from steel angles of sizes indicated and for attachment to concrete or steel framing. Provide slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and not more than 24 inches o.c., unless otherwise indicated.

B. Galvanize shelf angles to be installed on exterior concrete or steel framing.

2.07 FINISHES, GENERAL

A. Comply with NAAMM Metal Finishes Manual for recommendations relative to application and designations of finishes.

B. Finish metal fabrications after assembly.

C. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
   1. Galvanize ALL EXTERIOR EXPOSED structural shapes, lintels, shelf angles and decorative steel components.

D. Lead free, alkyd primer: Manufacturer's standard.

E. Weathering Steel (grade A325, Type 3).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

3.02 CLEANING

A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces.
   1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Worked covered by this Section includes furnishing of and paying for all materials, labor, services, equipment, licenses, taxes, other items, and appliances for execution, installation and completion of all work specified herein and/or shown on the drawings.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.04 QUALITY ASSURANCE

A. Design, engineer, fabricate and install handrails and railing systems to comply with requirements of ASTM E985 for structural performance based on testing performed in accordance with ASTM E 894 and E 935.

B. Structural design, fabrication and assembly shall be in accordance with requirements of NAAMM Metal Stairs Manual, except as otherwise specified or shown.

C. Design stairs to support a live load of 100 pounds per square foot.

D. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails and Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Infill of Guards:
      a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
      b. Infill load and other loads need not be assumed to act concurrently.

E. ASTM E 985 - For railing - related definitions and structural performance criteria.

F. Shop Drawings and Calculations must be stamped by a professional engineer licensed in the State where the work is located.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel Pipe: ASTM A53, Standard Weight.
   1. Shop primed for interior applications
   2. G90 hot dipped galvanized for exterior applications.

B. Rectangular Tubing: ASTM A500, Grade B or have equal yield, ultimate, and weldability properties.

C. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.

D. Plates, Shapes, and Bars: ASTM A 36/A 36M.

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

F. Steel Grating: Provide steel grating by McNichols Co., 1-800-237-3820, or approved equal:
   1. GRIP STRUT Grating, Galvanized Mill-Galv ASTM A525, 14 Gauge, 4 Diamond, 1-1/2" Channel Depth, Serrated Surface, Plank.

G. Sheet Steel: ASTM A366.

H. Structural Steel: ASTM A36.

I. Steel Floor Plate: ASTM 786.

J. Steel Decking: Form from steel conforming to ASTM A446, with properties conforming to AISI Specification for the Design of Cold-Formed Steel Structural Members. Shop primed for interior applications, zinc coated for exterior applications.

K. Stainless Steel
   1. Pipe & Fittings: Type 304 (18-8), Ornamental Grade, No.4 Satin Finish.
   2. Tubing: ASTM A 554, Grade MT 304
   3. Castings: ASTM A 743, Grade CF8 or CF20.
   4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.
   5. Bars and Shapes: ASTM A 276, Type 304.

2.02 METAL FABRICATION SCHEDULE

A. MTLST-01: Metal Stairs
Location: Interior – BOH Stairs

B. MTLST-02: Metal Stairs, plate steel stringers, concrete filled pan stairs. Bent plate steel guardrail. Steel handrail 1-1/4" tube steel (1-1/4" O.D.). Blackened steel finish – alternate deduct PT-04.
Location: Interior – VIP Stairs

C. MFAB-01 Guardrails at Music Hall
Product Model Information: Steel guardrails painted PT-04, with Jakob sleeveless webnet infill black oxide finish, without sleeves.
Location: Interior – Music Hall

D. MFAB-01A Guardrails at Music Hall
Product Model Information: Steel Guardrails painted PT-04, with McNichols wire mesh framed panel infill, square, welded 3X3 mesh 6-gauge carbon steel
Location: Interior – Music Hall

E. MFAB-02 Guardrails at Music Hall Seating
Product Model Information: Steel Guardrails painted PT-04
Location: Interior – Music Hall Seating

F. MFAB-03 Guardrails at Vinyl Room
Product Model Information: Blackened steel guardrails, welded and ground smooth. Jakob sleeveless webnet infill.
Location: Interior – Vinyl Room.

G. MFAB-04 Guardrails at Loading Dock
Product Model Information: Galvanized metal guardrails
Location: Exterior – Loading Dock

2.02 FASTENERS

A. Provide Type 304 or 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade and class required for conditions indicated and as specified.
1. At steel railings, use Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153.
2. At aluminum and stainless steel railings, use Type 304 or 316 stainless steel fasteners.

B. Bolts And Nuts: ASTM A 307, Grade A. High strength bolts; ASTM A 325. Hot-dip galvanize all items in accordance with ASTM A 153.

C. Expansion Bolts Wedge Anchors: Ramset "Trubolt" or Hilti "Kwik Bolt".

D. Expansion Shields: F.S. FF-S-325.

E. Anchor Bolts: Furnish and deliver to site, anchor bolts and other items to be embedded in concrete. Provide necessary shop details and diagrams for concrete forms and, if required, provide templates to insure proper and accurate locations and setting of anchor bolts.

F. Toggle Bolts: Tumble-wing type F.S. FF-B-588 type, class and style as required.

G. Lock Washers: F.S. FF-W-84, helical spring type carbon steel.

2.03 STAIR NOSINGS

A. Manufacturer: Balco-Metalines, Inc., P.O. Box 17249, Wichita, Kansas 67217, 1-800-767-0082, or approved equal.

B. At Concrete Stairs: Furnish and install Type R-315P, 3" wide x 1/4" thick, single component stair nosings. Provide Type 7 Concrete Anchor.

C. The single component ribbed surface non-slip stair nosings shall have abrasive ribs 1/4" thick, 1/16" above exposed aluminum. Extrude unit from mill finished Type 6063 T-5 aluminum. Formulate abrasive surface from 2 part epoxy combined with aluminum oxide grit. Color selected by Architect from standard abrasive colors. Abrasives with cementitious based resins will not be acceptable.

2.04 FABRICATION GENERAL

A. Verify dimensions on site prior to shop fabrication.

B. Fit and shop assemble components in largest practical sizes, for delivery to site and installation.

C. Supply components required for secure anchorage of stairs, handrails and railings.

D. Fully weld joints. Grind exposed welds smooth and flush with adjacent surfaces.

E. Make exposed butt joints tight, flush, and hairline.

F. Accurately form components required for anchorage of members to each other and to building structure.

G. Welding:
1. Structural steel, AWS D1.1 and sheet steel, AWS D1.3.
2. Where possible, locate welds on unexposed side.
3. Grind exposed welds smooth and true to contour of welded member. Remove welding splatter.

2.05 STEEL FINISH

A. Lead free, alkyd primer: Manufacturer's standard.

B. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to steel according to ASTM A 123/A 123M.
   1. Galvanize ALL EXTERIOR EXPOSED steel stair and railing components.

C. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
   1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
   3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mil.
   4. Color: Match Architect's sample

2.06 BLACKENED STEEL FINISHES

A. Items indicated to be fabricated of blackened steel shall be shop finished after fabrication and welding is complete. Shop finish shall consist of EZ Black 55 and Aquares 1200F by SurFin Chemical Corp (or approved equal); apply per manufacturer’s recommendations. Finish should be consistently black and maintain zero rust coloring. Provide matte lacquered finish.

B. Prior to application of finish, clean steel per SSPC SP-3. Ensure that base material is scratch and defect free prior to patination. Work piece should conform to catagory AESS 1

C. Protect surface of blackened steel from abrasion by coating with wax or oil.

2.07 CLOSED RISER STAIRS

A. Provide treads, risers, platforms, stringers, headers and other supporting members.

B. Fabricate pans for treads from sheet steel, and fabricate pans for platforms from steel decking. Form risers to have sanitary cove.

C. Fabricate stringers, headers, and other supporting members from structural steel.

2.08 OPEN RISER STAIRS AND INDUSTRIAL STAIRS

A. Provide treads, platforms, stringers and other supporting members.

B. Make treads and platforms of steel grating. Fabricate steel grating treads and platforms in accordance with the requirements of NAAMM Metal Bar Grating Manuals.

C. Support treads by use of carrier plates or carrier angle. Provide abrasive nosing on treads and edge of platforms at head of stairs. Furnish toe plates where shown.

2.09 STEEL RAILING SYSTEM

A. Rails and Posts: Sizes and shapes as indicated.

B. Mounting on Concrete Floor: Steel sleeves, sized to receive railing post with 1/4 inch clearance.

C. Mounting on Masonry or Concrete Walls: Provide brackets with anchors.

D. Mounting on Stud Walls: Provide brackets and anchor plates, predrilled to receive bolts.

E. Splice Connectors: Steel threaded collars.

PART 3 - EXECUTION

3.01 PREPARATION

A. Supply items to be embedded in masonry or concrete or placed in partitions with setting templates and erection drawings to approximate sections.

3.02 STAIR INSTALLATION

A. Provide hangers and struts required to support the loads imposed.

B. Perform job site welding and bolting as specified for shop fabrication.

C. Set stairs and other members in position and secure to structure as shown. Install stairs plumb, level and true to line.

3.03 RAILING INSTALLATION

A. Provide standard terminal fittings at ends of posts and rails.

B. Secure brackets, posts and rails to steel by welds, and to masonry or concrete with expansion sleeves and bolts, except secure posts at concrete by setting in sleeves filled with commercial non-shrink grout.

C. Set rails horizontal or parallel to rake of stairs to within 1/8-inch in 12 feet.

D. Set posts plumb and aligned to within 1/8-inch in 12 feet.

3.04 FIELD PRIME PAINTING

A. When installation is complete, clean field welds and surrounding areas to bright metal, and coat with same primer paint used for shop priming.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Decorative metal fabrications

1.3 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

C. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.

D. Samples for Verification: For each type of exposed finish.

1. Sections of linear shapes.
2. Full-size Samples of castings and forgings.

a. For custom castings, submit finished Samples showing ability to reproduce detail and quality of finish.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. MTL-02: Curtain Wall Mullions
Product Model Information: Coated aluminum framing to match PT-03
Location: Exterior Façade – Curtain Wall Framing Finish

B. MTL-04: Ceiling Grating
Product Model Information: Suspended, UNISTRUT P5000 20PL, 3-1/4” deep X 1-5/8” wide rectangular steel section arranged in an approximate 4’x4’ grid.
Plain Finish
Location: Interior – Level 1 Ceiling Finish

2.3 STEEL AND IRON

A. MTL-13: Expanded Metal Mesh
Product Model Information: Amico Bellesa
Finish: Bare Steel Finish
Location: Interior – Bar Fronts

B. MTL-14: Expanded Metal Mesh
Product Model Information: Amico Apex-03
Finish: Bare Steel Finish
Location: Interior – Proscenium Wall

C. MTL-15: Stainless Steel
Product Model Information: Stainless Steel Sheet, sized per architect’s drawing
Finish: Non directional finish
Location: Lobby Bar – Laminated to stop of ST-02

D. MTL-21: Metal Shower Partition
Product Model Information: Black epoxy painted metal, matte finish w/ glass infill.

Location: Interior – Shower Partition

2.4 ARCHITECTURAL PAINTED STEEL

A. Size: Refer to Drawings

B. Finish: Shop Primed, Field Painted

C. Quality: Welds To Be Smooth, Clean And Mitered Where Possible

D. Weld Connections - Category 1 AESS: Comply With AWS For Tolerances, Appearances, Welding Procedure Specifications, Weld Quality, And Methods Used In Correcting Welding Work, And Comply With The Following:
   1. Assemble And Weld Built-Up Sections By Methods That Will Maintain True Alignment Of Axes Without Exceeding Specified Tolerances.
   2. Use Weld Sizes, Fabrication Sequence, And Equipment For Aess That Limit Distortions To Allowable Tolerances.
   3. Provide Continuous, Sealed Welds Of Uniform Size And Profile Where Category 1 AESS Is Welded.
   4. Grind Butt And Groove Welds Flush To Adjacent Surfaces Within Tolerance Of Plus 1/16 Inch, Minus Zero Inch For Category 1 AESS.
   5. Make Butt And Groove Welds Flush To Adjacent Surfaces Within Tolerance Of Plus 1/16 Inch, Minus Zero Inch For Category 1 AESS. Do Not Grind Unless Required For Clearances Or For Fitting Other Components, Or Unless Directed To Correct Unacceptable Work.
   6. Remove Backing Bars Or Runoff Tabs; Back-Gouge And Grind Steel Smooth For Category 1 AESS.
   7. At Locations Where Welding On The Far Side Of An Exposed Connection Of Category 1 AESS Occurs, Grind Distortions And Marking Of The Steel To A Smooth Profile Aligned With Adjacent Material.
   8. Make Fillet Welds For Category 1 AESS Oversize And Grind To Uniform Profile With Smooth Face And Transition.
   9. Make Fillet Welds For Category 1 AESS Of Uniform Size And Profile With Exposed Face Smooth And Slightly Concave. Do Not Grind Unless Directed To Correct Unacceptable Work.

E. Surface Preparation [For Nongalvanized Steel]: Clean Surfaces To Be Painted. Remove Loose Rust And Mill Scale And Spatter, Slag, Or Flux Deposits. Prepare Surfaces According To The Following Specifications And Standards:
   1. SSPC-SP 2, "HAND TOOL CLEANING."
   2. SSPC-SP 3, "POWER TOOL CLEANING."

F. Set AESS Accurately In Locations And To Elevations Indicated And According To AISC 303 And AISC 360. Erect Category 1 AESS To The Tolerances Specified In AISC 303 For Steel That Is Not Designated AESS.

2.5 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

J. Comply with AWS for recommended practices in shop **welding and brazing**.

K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

D. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in 09 9000

E. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

F. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

G. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Includes: Provide rough carpentry, and installation of items specified in other Sections, normally installed by carpenters.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Material Grading: Identify hardboard, particleboard, lumber, and plywood by affixing grademark, stamp, or related identifying marks indicating material grades, rules or standards under which they are produced, and complying with rule or standard under which the material is produced. Use certified inspection agency certified by the Board of Review, American Lumber Standards Committee, to grade lumber species. In lieu of piece grademarking, a certificate of inspection from an agency certified by the Board of Review, American Lumber Standards Committee may be furnished for precut lumber. Applicable grading rules are as follows:

1. Douglas Fir, White Fir, and Cedar: "Standard Grading and Dressing Rules for West Coast Lumber" as published by the West Coast Lumber Inspection Bureau.
2. Ponderosa and Western White Pine: "Grading Rules for Western Lumber", published by the Western Wood Products Association.
3. Southern Yellow Pine: "Standard Grading Rules for Southern Pine Lumber" as published by the Southern Pine Inspection Bureau.

B. Plywood: Conform to U. S. Product Standard PS 1 issued by the National Bureau of Standards. Stamp or brand each standard size panel to show type and grade of panel. When used structurally, plywood to meet performance standards for its type as described in Product Standard PS 1 for Douglas Fir plywood. Furnish material identified as to species, grade, and glue type by an approved agency or independent testing laboratory with appropriate affixed grade-marks on each panel. Provide in addition to above requirements, exterior type plywood for permanently exposed plywood in outdoor applications.

C. Qualifications of Workmen: Provide sufficient skilled workmen and carpenter foreman present at all times during execution of this portion of the Work, thoroughly familiar with type construction involved, materials and techniques specified.

1.05 PRODUCT HANDLING

A. Protection:
   1. Store materials to ensure proper ventilation and drainage. Protect against damage and weather.
   2. Deliver materials to job site and store, in safe area, out of the way of traffic, and shored off ground surface.
   3. Identify framing lumber as to grades and store grades separately.
   4. Protect metal products with adequate weatherproof outer wrappings.
   5. Use extreme care in off-loading lumber to prevent damage, splitting, and breaking materials.

B. Replacements: In event of damage, immediately make repairs and replacements necessary to approval of Architect at Contractor's expense.

PART 2 - PRODUCTS

2.01 LUMBER

A. Provide lumber for structural carpentry using following species provided grade for each is not lower than minimum shown:
   1. Pine, Southern Yellow - SPIB Rules (KD) No. 2 Common
   2. Fir, Douglas - WCLIB Rules Standard
   3. Fir, White - WCLIB Rules Standard
   4. Pine, Western White - WWPA Rules Standard

B. Lumber (except where otherwise noted): Surfaced 4 sides unless, in addition to being dressed, it has been notched, shiplapped, or patterned.

C. Lumber Dimensions: Are nominal.

2.02 PLYWOOD

A. Plywood (not otherwise specified or noted on the Drawings): Comply with DOC PS-1, Exposure 1 (exterior glue), Group 1, Southern pine, C-D grade for concealed applications and B-C grade for exposed “utility” applications.
   1. Refer to 06 4000 for exposed “Architectural” applications.

B. Plywood Wall Sheathing at Metal Panels and Composite Metal Panels: 5/8" APA Rated Sheathing, Structural I, C-C or C-D Exterior Grade

C. Wall Panels at Data/Electrical Rooms: ¾” B-C, Painted Flat White.

2.03 FIRE-RETARDANT AND PRESERVATIVE TREATMENT

A. Wood-Preservative-Treated Lumber And Plywood
   1. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground
   2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
   3. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
   4. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   5. Application: Treat items indicated on Drawings, and the following:
      a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
      b. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
      c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
      d. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
      e. Wood floor plates that are installed over concrete slabs-on-grade.

B. Fire-Retardant Treated Lumber And Plywood
   1. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
   2. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   3. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
   4. Interior Type: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
   5. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

6. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
7. Application: Treat items indicated on Drawings

2.04 HARDWARE

A. Provide rough hardware required for proper installation of carpentry work. Furnish hot-dipped galvanized, nails, spikes, screws, bolts, and similar items using proper types and ample sizes to fasten and hold the various members securely in place.

B. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, fire retardant treated, or in area of high relative humidity, provide fasteners **with hot-dip zinc coating complying with ASTM A 153/A 153M or Type 304 stainless steel**.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Carpentry: Produce joints true, tight, and well nailed. Lay out, install and fit wood framing, furring, stripping, and blocking as required by conditions encountered.

B. All Work: Plumb, level, and brace with sufficient nails, spikes, and bolts required to ensure secure attachment and rigidity.

C. Any piece of work or carpentry material with defects that prevent it from serving its intended purpose satisfactorily, including crooked, warped, bowed, or otherwise defective material, even if within the limits of grade specified, will be rejected. Replace with an acceptable piece.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Extent of gypsum sheathing is shown on the drawings and described in this section.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Gypsum Board Terminology Standard: GA-505 by Gypsum Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver gypsum sheathing with factory identification of brand and grade. Protect from damage and direct exposure to severe weather. Store on leveled supports off the ground.

PART 2-PRODUCTS

2.01 MATERIALS

A. Gypsum Sheathing:
   1. Manufacturer:
      a. "Dens-Glass Gold" by Georgia Pacific Corporation.
      b. "GlasRoc" by Certainteed
      c. "Green Glass" by Temple-Inland
      d. "Secur Rock" by USG
   2. Provide 4'-0" x 8'-0" x 5/8”. Fabricate sheathing with fiberglass mat facing on both sides and conforming to ASTM C-1177 for core requirements. Provide sheathing classed as noncombustible when tested by ASTM E136 with Flame Spread and Smoke Developed rating of 0 when tested by ASTM E84.

B. Fasteners: Provide 1", Type S-12, bugle-head screws, corrosion resistant treated.
   1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
   2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer's instructions and industry standards for the installation of gypsum sheathing.

B. Horizontal Installation: Install wide panels horizontally with end joints on supports and staggered 2 support spacings where possible, but not less than one support spacing or 12". Fasten at each support with screws (spaced approximately 8" o.c.) set back 3/8" minimum from edges.

C. Cut boards at penetrations, edges and other obstructions of the work; fit tight against abutting work, except provide 3/8" setback where non-loadbearing work abuts structural elements at head and jambs.

D. Do not bridge building expansion joints with gypsum sheathing; cut and space edges to match spacing of structural support elements.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish and install millwork, hardware and accessories specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.
   1. Shop Drawings: Submit newly prepared architectural woodwork Shop Drawings for review by Architect prior to start of fabrication. Do not duplicate Architect's construction drawings. Indicate on shop drawings, dimensions, species, matching of panels, profiles of moldings, assembly details, applied finish, surfacing, built-in hardware, and necessary connections to other trades.
      a. Contract Document electronic files (including all drawings, specifications, addenda and supplemental information) will not be made available to Bidders or Sub-bidders before the award of a Contract. After the award of the Contract, the General Contractor may make request for release of electronic document files.
   2. Brochures: Submit manufacturer's descriptive literature on specialty items not manufactured by the architectural woodworker, as requested by Architect.
   3. Samples to be Submitted:
      a. Finished pieces of each wood species to receive transparent finish.
      b. Each plastic laminate and melamine laminate.
      c. Each type of edge band material.
      d. Each solid surface material.
      e. Metal Trim
      f. Upholstery Fabric

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Standards:
   1. Architectural Woodwork Standards of the Architectural Woodwork Institute (AWI) are referenced in this specification, however, where more stringent requirements are specified, the more stringent shall govern. Any reference to Premium, Custom or Economy in this specification is as defined in latest edition of the AWI "Architectural Woodwork Standards " and as modified in this specification.

2. Provide Custom grade for any item not given a specific quality grade as defined in latest edition of the AWI "Architectural Woodwork Standards"

B. Competence: Approved woodwork manufacturer, regularly engaged and well experienced in manufacture of fixtures and wood trim and finish of monumental building type, having reputation for doing satisfactory work on time and successfully completing comparable work. Architect reserves the right to approve woodwork manufacturer selected to furnish woodwork.

1.05 FIELD DIMENSIONS

A. Woodwork manufacturer is responsible for details and dimensions not controlled by job conditions. Show on Shop Drawings all required field measurements beyond his control. General Contractor and the woodwork manufacturer shall cooperate to establish and maintain these field dimensions.

1.06 PRODUCT HANDLING

A. Protection: Protect architectural woodwork before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary to approval of Architect and at Contractor's expense.

PART 2 - PRODUCTS

2.01 MATERIALS FOR ARCHITECTURAL WOODWORK

A. Stain and Natural Finish:
1. Exposed Solid Wood: Grade I, Plain Sliced.
2. Semi-exposed Solid Wood: Grade II, compatible species to exposed.
3. Concealed Solid Wood: Mill option hardwood.
4. Exposed Plywood: "AA" Face Veneer, Plain Sliced, Slip Matched, Clear Maple on ANSI A208 Grade 155 Medium Density Fiberboard (MDF) Core.
5. Semi-exposed Plywood: Mill option hardwood veneer.
6. Concealed Plywood: Mill option.
4. FR Treated Exposed Plywood: "AA" Face Veneer on Arauco Trupan Flame Retardant MDF
5. FR Treated Semi-exposed Plywood: Mill option hardwood veneer on Arauco Trupan Flame Retardant MDF.

PLY-01: Plywood, Type 1
Product: Douglas Fir A/C Plywood
Class B
Finish: SE Johnson Paste Wax
Thickness: ¾”
Note: Plywood panel layouts will require Design Team selection and arrangement of patterned plywood panels. Subject to initial Architect approved samples, mock-ups, and final layout.

PLY-02: Plywood, Type 2
Product: Douglas Fir A/C Plywood
Class B
Finish: SE Johnson Paste Wax
Thickness: ½”
Note: Subject to initial Architect approved samples and mock-ups.

PLY-03: Plywood, Type 3
Product: Douglas Fir A/C Plywood
Finish: Sem-Transparent True Black Miniwax Stain to match Architect’s sample
Thickness: ¾”
Note: Plywood panel layouts will require Design Team selection and arrangement of patterned plywood panels. Subject to initial Architect approved samples, mock-ups, and final layout.

WD-01: Wood, Type 1
Species: White Oak
Thickness: 1”
Grain: Solid Oak
Finish: Sealed Matte Finish
Stain: Dark Brown
Note: To match SC finish sample provided.

WB-01: Painted Wood Base
Paint-Grade Poplar
Profile: 3/4" x 2", Chamfer Edge to Match RB-01 & RB-02 Profiles
Color: PT-12
Installation method: Applied

B. Paint Finish:
1. Exposed Solid Wood: Close grained hardwood.
2. Semi-exposed or Concealed Solid Wood: Mill option.
3. Exposed Plywood: Hardwood veneer medium density overlay (MDO).

C. Substrate for High Pressure Laminated Plastic Finish:
1. Typical: ANSI A208 Grade 155 Medium Density Fiberboard (MDF).
2. At Sinks and Lavatories: All Hardwood veneer core plywood with each veneer layer bonded with exterior glue.

PL-01: Plastic Laminate, Type 1
Manufacturer: Lab Designs
Pattern: Burnt Apple WA323
Finish: LS

PL-02: Plastic Laminate, Type 2
Manufacturer: Wilsonart
Pattern: 15505 Black Velvet
Finish: 31 - Traceless

D. Substrate for Thermally Fused "Melamine" Laminate Finish:
1. ANSI A208 Grade 155 Medium Density Fiberboard (MDF) with factory laminated "Melamine" finish on both sides.
2. Melamine at Cabinet Interiors to be White.

E. Solid Surface Material:

SS-01: Solid Surface, Type 1 (subject to change)
Manufacturer: LX Hausys
Product: HIMACS
Color: Black
Thickness: ½”
Notes: miter all corners unless otherwise noted

SS-02: Solid Surface, Type 2
Manufacturer: LX Hausys
Product: HIMACS
Color: Ivory White
Thickness: ½”
Notes: miter all corners unless otherwise noted

F. Quartz Material:

QS-01: Quartz Surface, Type 1
Manufacturer: Cambria
Product: Blackpool
Finish: Matte
Thickness: 2cm
Notes: miter all corners unless otherwise noted

~~QS-02: Quartz Surface, Type 2~~
~~Manufacturer: Cambira~~
~~Product: Blackpool~~
~~Finish: Matte~~
~~Thickness: 3cm~~

QS-03: Quartz Surface, Type 3
Manufacturer: Caesarstone
Product: 4004 Raw Concrete
Thickness: 2cm
Notes: miter all corners unless otherwise noted

SECTION 09 6500 - RESILIENT FLOORING

RB-01: Rubber Base, Color 1
Manufacturer: Johnsonite
Profile: Millwork/Mandalay MW-71-H3
Color: Stormcloud 71

RB-02: Rubber Base, Color 2
Manufacturer: Johnsonite
Profile: Millwork/Mandalay MW-63-H3
Color: Burnt Umber 63

G. UPHOLSTERED CUSHION ON BENCH
Cushion description: cold molded foam cushion (high density) with a top layer of batting
Thickness: 3” minimum thickness across cushion, 2” minimum thickness at thinnest location (ie: rolled edge)
Attachment Method: Concealed
Profile: radius/rolled at front edge; square at side edges
Fabrication: fabric pattern, if any, must align at seams; no piping will be used; provide bottom cover

UP-01: Upholstery, Type 1
Manufacturer: The Mitchell Group
Pattern: Hayden
Color: Lily

UP-02: Upholstery, Type 2
Manufacturer: Kvadrat Febrik
Pattern: Mosaic 2
Color: 972

H. Metal Trim to be incorporated into Millwork: Refer to 05 7000,

I. CC-01: Colored Concrete Countertop
Products | HUGUET
Color: TBD

2.02 FACTORY FINISH

A. Shop finish architectural woodwork in accordance with requirements of AWI Architectural Woodwork Standards for Premium Finish.
1. Finish System: AWI Architectural Woodwork Standards, Chapter 5, System 11 Catalyzed Polyurethane with custom stain color to be selected by architect.
a. Close Grain Woods:
Washcoat
Custom Stain
Sealer
Sand
Top Coat
Top Coat
b. Open Grain Woods:
Custom Stain
Sealer
Sand
Top Coat
Top Coat
2. Apply finish to all faces and edges that receive stain finish.

2.03 TRIM

A. Fabricate according to AWI Architectural Woodwork Standards for Premium Grade.

2.04 MILLWORK

A. Fabricate according to AWI Architectural Woodwork Standards for Premium Grade, Flush Overlay type.

B. Hardware: Install cabinet hardware furnished under this Section of these Specifications.

C. Edge Banding:
1. At painted and stained millwork, provide either solid wood or pressure applied tape as shown on drawings. **IRONED ON TAPE EDGE BANDING WILL NOT BE ACCEPTED.**
2. At HP Laminate and Melamine Laminate millwork
a. At Countertop Edges: Provide 3mm PVC
b. At Door, Drawer and Cabinet Body Edges: Provide 1mm PVC

c. At Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.

D. Drawer Construction: Drawers are to be four sided, drawer box type. Head screw from the inside of the drawer box and install pulls through the drawer box.
1. Solid wood construction at painted or stained finish millwork
2. ANSI A208 Grade 155 Medium Density Fiberboard (MDF) with factory laminated "Melamine" finish on both sides at HPL or melamine finish millwork.

2.05 HARDWARE

A. Cabinet Doors:
1. 1 Pair Hinges: Blum # BH73B3550, Soft Close, 110+ Degree Clip Top Hinge, Full Overlay Style, US26D.
2. 1 Pull: Liberty Hardware, Modern Flat E Bar Pull, 128 MM, Stainless Steel
3. 1 Camlock NCL-C8053-C413A-Y21 – Matte Black Cylinder Cam Lock By Compx National, where required, masterkeyed and keyed alike in groups as directed by Architect.

4. Provide self-adhesive rubber silencers at each corner of the leading edge of cabinet doors.

B. Cabinet Drawers:
1. 1 Pair Drawer Slides: KV1805 (Length as required), roller bearing, 3/4 extension lift-out, hold in/out, lock open, self closing.
   a. Provide medium duty model 8417, full extension drawer slides at file drawers and all drawers over 7" deep.
   b. Heavy-Duty, Soft-Close, Undermount Waste & Recycling Bin Hardware to be KV USCxx-2-xx with optional QTxxPB-PT Bins (2) included.
2. 1 Pull: Liberty Hardware, Modern Flat E Bar Pull, 128 MM, Stainless Steel
3. 1 Camlock NCL-C8053-C413A-Y21 – Matte Black Cylinder Cam Lock By Compx National, where required, masterkeyed and keyed alike in groups as directed by Architect.

C. Adjustable Shelf Support:
1. Wood Shelves: Millwork subcontractor to install recessed standards and clips.
2. Glass Shelves: Aluminum wall mounted standards and aluminum brackets.
   a. GL-05 Translucent Glass, 3/16" Thick Translucent Glass, Interior - Bar Shelving

D. Concealed Counter Support Bracket: A&M Hardware Inc., Flat Bracket Model ECFLAT (length as required) with upper extension “EC”. Finish color to be selected by Architect.

E. Grommets: Doug Mockett & Co., 1-800-523-1269
1. Typical: “XG” 3” plastic where shown on millwork drawings. Color to be selected. Exact locations to be verified with Architect before installation.
2. Trash Grommet: TM8B , Finish: TBD, refer to drawings for location (FOH Multi-stall RR)

PART 3 - EXECUTION

3.01 FABRICATION

A. Fabricate millwork, ornamental wood, and countertops to comply with reviewed Shop Drawings and referenced standards.

3.02 UNDER-COUNTER AND BUILT-IN ITEMS COORDINATION

A. Prior to fabrication, verify exact location of specified and Owner Furnished under-counter and built-in items. Verify dimensions of appliances and equipment to be installed within the millwork. Notify Architect immediately of any dimensional discrepancies that would interfere with installation of under-counter or built-in items.

3.03 CABINET INSTALLATION

A. Grade: Install cabinets to comply with same grade as item to be installed.

B. Assemble cabinets and complete fabrication at Project site to the extent that it was not completed in the shop.

C. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
   1. For shop finished items use filler matching finish of items being installed.

F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
   2. Maintain veneer sequence matching of cabinets with transparent finish.
   3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips

G. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.04 STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary. Stagger joints in adjacent and related standing and running trim. [Cope] [Miter] at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
   1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
   2. Install trim after gypsum-board joint finishing operations are completed.
   3. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.05 PANELING INSTALLATION

A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.
   1. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners and adhesive as recommended by panel manufacturer.
   2. Conceal fasteners to greatest practical extent.
   3. Arrange panels with grooves and joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer. Use fasteners with prefinished heads matching groove color.

3.06 FINAL INSPECTION

A. General: Prior to final inspection and acceptance by Architect, completely check each installed item and adjust for proper operation.

B. Compliance:
   1. Owner reserves right to request and pay for inspection by representative of the Architectural Woodwork Institute to determine that work of this Section has been performed to comply with referenced standards.
   2. In event above inspection determines architectural woodwork, or any part of it does not comply with referenced standards, contractor pays all costs for initial inspection and all subsequently required reinspections. Immediately remove non-complying items, and immediately replace them with items complying to referenced standards of these specifications, at Contractor's expense.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

1.02 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

PART 2 – PRODUCTS

2.1 DESIGN AND PERFORMANCE REQUIREMENTS

A. General: Provide waterproofing that prevents the passage of liquid water with hydrostatic pressure and complies with requirements as demonstrated by testing performed by an independent testing agency of the Manufacturer's current sheet membrane.

1. Compatibility: All materials and components of sheet waterproofing shall be chemically compatible and adhesion compatible to each other and produced, supplied or approved by the system manufacturer. Materials and components of the system shall also be chemically and adhesion compatible with any adjacent waterproofing, weather barrier materials in which they may come in contact. If any components are not compatible, provide an intervening material to establish compatibility.

2.2 MANUFACTURERS

B. Acceptable Manufacturers: Subject to compliance with requirements, provide sheet waterproofing by one (1) of the following:

1. GCP Applied Technologies.

2. Carlisle Coatings and Waterproofing.

3. Henry.

C. Basis of Design (BOD): When particular manufacturers' materials, products or processes are specified for an item of Work, any one thereof is acceptable for the Contractor to

choose. An alternative material, product or process will be considered if the Contractor submits a written substitution request together with all such information as may be necessary to assist the Architect in determining whether the proposed substitution is acceptable, the burden of proof rests solely upon the Contractor.

D. Products of other manufacturers will be considered only if evidence is furnished showing compliance with the minimum design and performance requirements specified.

2.3 SHEET WATERPROOFING MATERIALS / SYSTEMS

A. Pre-Applied (Blind-Side) Sheet Waterproofing Membrane System **[WPS-01]**: Pre-applied membrane, factory-made composite, composed of high-density polyethylene film, synthetic rubber adhesive and a protective coating, a detackifying surface treatment, an uncoated self-adhering side lap strip, and a release liner formed into uniform flexible sheets.

1. Basis-of-Design Product Selection: Subject to compliance with requirements, provide one of the following systems:

a. GCP Applied Technologies, "PREPRUFE 300R Plus".

1) Alternate for Vertical Applications only: GCP Applied Technologies, "PREPRUFE 160R"

a) Elongation: 500% min.; ASTM D412 Modified.

b) Lateral Water Migration Resistance: ASTM D5385 modified; Pass at 231 ft. of hydrostatic head pressure.

c) Peel Adhesion to Concrete: 5.0 lb./in. min. ASTM D903, modified.

d) Lap Peel Adhesion: 5.0 lbs/in. width min.; ASTM D1876, modified.

e) Low Temperature Flexibility: Unaffected at -20 deg F. ; ASTM D1970.

f) Tensile Strength - Film: 4000 psi min; ASTM D412.

g) Hydrostatic Head Resistance: 231 ft. minimum; ASTM D5385, modified.

h) Permeance to Water Vapor Transmission: Maximum 0.01 perms ; ASTM E96 Method B.

i) Puncture Resistance (ASTM E154):

(1) 100 lbf. min. ("Preprufe 160R")

(2) 221 lbf. min. ("Preprufe 300R Plus")

j) Nominal Thickness (ASTM D3767):

(1) 0.032in. thick ("Preprufe 160R")

(2) 0.046 in. thick ("Preprufe 300R Plus")

2) Other Systems:

a) Carlisle Coatings & Waterproofing, "MiraPLY-H/V".

b) Henry Company, “PreSeal”

B. Self-Adhered (Laid-Back, Exposed) Sheet Waterproofing Membrane System **[WPS-02]**: Self-adhered, factory- made cold-applied composite sheet membrane consisting synthetic non-asphaltic adhesive and multi-layer cross-laminated, high density polyethylene film specially formulated for use with the specified pre-applied membrane, and covered release liner formed into uniform flexible sheets.

1. Basis-of-Design Product Selection: Subject to compliance with requirements, provide the following, or approved equal:

a. GCP Applied Technologies, "PREPRUFE 800PA".

1) Physical Properties: Product selected complies with the following minimum physical characteristics:

a) Thickness: 30 mils nominal; ASTM D3767,

b) Method A

c) Tensile Strength: 1000 psi minimum; ASTM D412, Die C, modified.

d) Ultimate Elongation: 150% minimum; ASTM D412.

e) Low-Temperature Flexibility: Pass at -25 deg. F. ; ASTM D1970.

f) Crack Cycling: Unaffected after 100 cycles at - 25 deg. F. ; ASTM C836.

g) Puncture Resistance: 100 lbf min.; ASTM E154.

h) Hydrostatic-Head Resistance: 231 ft. minimum; ASTM D5385.

i) Water Absorption: 0.10% weight gain maximum; ASTM D570.

j) Vapor Permeance: Less than 0.01 perms; ASTM E96, Water Method.

2) Other Systems:

a) Carlisle Coatings & Waterproofing, " CCW-MiraDRI 860/861”

b) Henry Company, "Blueskin WP 200"

2.4 ACCESSORIES

A. Slab Conditioners, Liquid Membrane, Primers, Patching Membranes, Sheet Strips, Mastics, Adhesives, Cleaners, Fillets, Internal and External Angles and Flashings: As recommended by the membrane manufacturer for the purpose intended and compatible with membrane, and with the materials to which it is bonded.

B. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4 in. wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.

C. Joint Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 8 in. wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.

D. Tieback Covers: Prefabricated ABS plastic covers with waterproof flexible membrane covering as recommended by waterproofing manufacturer for sealing tie back anchors in soil retention systems.

E. Metal Termination Bars: Aluminum bars, approximately 1 in. x 1/8 in. thick, predrilled at 9 in. centers.

F. Protection Board: Premolded, 1/8 in. thick for vertical surfaces and 1/4 in. thick for horizontal surfaces, semi-rigid board complying with ASTM D6506 Type 2 Class B consisting of mineral stabilized core sandwiched between layers of asphalt saturated felt, surface coated with asphalt and sealed to core under heat and pressure and provided with polyethylene film facings.

G. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to 1 side and a polymeric film bonded to the other side of a 3-dimensional, non-biodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm/ft. .

H. Waterstops: The following waterstops shall also be used where acceptable to waterproofing system manufacturer for use at below-grade, non-moving construction joints:

1. Hydrophilic Waterstops:

a. GCP Applied Technologies, "ADCOR 500S"

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

1.02 12 PT ALL CAPS AND BOLD

A.
1.
2.
a)
b)
1)
2)

B.

PART 2 – PRODUCTS

2.1 DESIGN AND PERFORMANCE REQUIREMENTS

A. General: Cold fluid-applied membrane roofing and flashing system with compatible components that will not permit passage of liquid and withstands wind loads, building movement, traffic loads, thermally induced movement, and exposure to weather without failure.

1. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

2. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

3. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D3746 or ASTM D4272.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. Roofing System Design: Tested by a qualified testing agency to resist the following uplift pressures:

1. Corner Uplift Pressure: **TBD** lbf/sq. ft..

2. Perimeter Uplift Pressure: **TBD** lbf/sq. ft..

3. Field-of-Roof Uplift Pressure: **TBD** lbf/sq. ft..

D. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: **Class 1A-120 TBD**.

2. Hail Resistance Rating: **VSH**

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide fluid applied protected membrane roofing system and products of one (1) of the following:

1. American Hydrotech, Inc.

2. Soprema.

3. Siplast.

B. Basis of Design (BOD): When particular manufacturers' materials, products or processes are specified for an item of Work, any one thereof is acceptable for the Contractor to choose. An alternative material, product or process will be considered if the Contractor submits a written substitution request together with all such information as may be necessary to assist the Architect in determining whether the proposed substitution is acceptable, the burden of proof rests solely upon the Contractor.

1. Products of other manufacturers will be considered only if evidence is furnished showing compliance with the minimum design and performance requirements specified.

2.3 FLUID APPLIED ROOFING MATERIALS

A. Roof Membrane System (**RS-02**): Prefabricated, reinforced, homogeneous Styrene-Butadiene-Styrene (SBS) block copolymer modified asphalt membrane applied over a prepared substrate, covered with a liquid applied, flexible, polymethylmethacrylate (PMMA) based monolithic membrane formed by the combination of liquid PMMA resin and fleece fabric.

1. Prefabricated, reinforced, homogeneous Styrene-Butadiene-Styrene (SBS) block copolymer modified asphalt membrane applied over a prepared substrate.

2. Resin for Field Membrane Construction: A flexible, polymethylmethacrylate (PMMA) based resin for use in combination with fleece fabric to form a monolithic, reinforced membrane.

a. Parapro Resin by Siplast; Irving, TX

b. Alsan RS System by Soprema; Wadsworth, OH

c. HydroSeal Fleece Reinforced Deck Membrane; American Hydrotech, Inc.

3. Fleece for Field Membrane Reinforcement: A non-woven, 110 g/m², needle-punched polyester fabric reinforcement as supplied by the membrane system manufacturer.

a. Pro Fleece by Siplast; Irving, TX

b. Alsan RS Fleece by Soprema; Wadsworth, OH

c. HydroSeal Fleece Reinforcement; American Hydrotech, Inc.

4. Flashing Membrane Assembly: A flashing membrane assembly consisting of a liquid applied, flexible, polymethylmethacrylate (PMMA) based monolithic membrane formed by the combination of liquid PMMA-based resin and non-woven, chopped strand, polyester fabric reinforcement to achieve a minimum thickness of 90 mils.

a. Siplast Parapro Waterproofing System.

b. Soprema Alsan RS 230 System.

c. HydroSeal Flashing: American Hydrotech, Inc.

2.4 ACCESSORIES

A. Slab Conditioners, Liquid Membrane, Primers, Patching Membranes, Sheet Strips, Mastics, Adhesives, Cleaners, Fillets, Internal and External Angles and Flashings: As recommended by the membrane manufacturer for the purpose intended and compatible with membrane, and with the materials to which it is bonded.

B. Elastomeric Flashing Accessories:

1. Bonding Adhesive: Manufacturer's one-component neoprene base contact adhesive specifically recommended for applying sheet flashing to vertical surfaces.

2. Splicing Cement: Manufacturer's synthetic rubber-base polymer adhesive specifically recommended for securing vertical laps in sheet flashing.

3. Lap Seal: Manufacturer's EPDM or synthetic rubber sealant specifically recommended for sealing lap joints in sheet flashing.

4. Water Block Mastic: Manufacturer's recommended mastic for bedding flashing anchors.

C. Reinforcing Sheet; Continuous filament needle-punched spun bond polyester bonded with an acrylic binder nominal, 1.0 oz./yd2 weight, and as recommended by the roofing membrane manufacturer.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

2.5

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 MINERAL FIBER INSULATION

A. Mineral Wool Fiber Rain Screen Insulation **[INS-01]:** ASTM C612, Type IVB. Semi-rigid rock wool fiber board with water-resistant binder. ASTM C518, thermal conductivity of "k" = 0.24 Btu in/hr/sq. ft./deg F at 75 deg F. Water absorption, ASTM C1104, 0.03 by volume. Minimum density 4.4 lb/cu. ft.. Provide manufacturer's standard sizes, for use in rain screen construction, in thickness indicated.

1. Rockwool "CavityRock"

2. Owens Corning "Thermafiber RainBarrier"

3. Johns Manville "JM Cladstone 45 Water & Fire Block"

B. Mineral Wool Fiber Rain Screen Insulation with Black Facing **[INS-01A]:** ASTM C612, Type IVB. Semi-rigid rock wool fiber board with water-resistant binder and integral black scrim facing. ASTM C518, thermal conductivity of "k" = 0.24 Btu in/hr/sq. ft./deg F at 75 deg F. Water absorption, ASTM C1104, 0.03 by volume. Minimum density 4.4 lb/cu. ft.. Provide manufacturer's standard sizes, for use in rain screen construction, in thickness indicated.

1. Rockwool "CavityRock Black"

2. Owens Corning "Thermafiber RainBarrier Dark"

2.02 PLASTIC INSULATION

A. Polyisocyanurate Board Insulation **[INS-02]**: Rigid insulation panel faced with fiber reinforced facer on both exterior and interior sides with core of preformed, rigid, cellular, polyisocyanurate thermal insulation complying with ASTM C1289, Type 1, Class 2, with a minimum long-term thermal resistance (LTTR) value of R5.6 at 75 deg F. for 1 in. thick board. At areas where tapered insulation is scheduled, provide first layer insulation board without the high-density fiber board. Provide one of the following:

1. "ENRGY 3 Plus " (Johns Manville)."

2. "ACFoam Composite" (Atlas Roofing Corporation)."

3. "EnergyGuard Polyiso Insulation Board" (GAF Materials Corporation)."

B. Extruded Polystyrene Board **[INS-03]:** ASTM C578, Type IV. Rigid closed-cell polystyrene foam board. ASTM C518, thermal conductivity of “k" = 0.20 Btu in/hr/sq. ft./deg F at 75 deg F, when fully aged at 5 years. ASTM D1621, 25 psi compressive strength. ASTM E96/E96M water vapor permeance rating of maximum 1.1 perm. Provide manufacturer's standard sizes in thickness and thermal resistance “R" values indicated.

1. DuPont “GWP Styrofoam Cavitymate Plus or Square Edge"

2. Owens-Corning “Foamular NGX 250"

3. Kingspan Insulation LLC “GreenGuard GG300”

C. Concrete Faced Insulated Wall Panels **[INS-04]:** Extruded polystyrene board, ASTM C578, Type IV, rigid, closed cell, with integral high density skin, with integral 5/16 inch thick latex-modified concrete facing. Thermal resistance: Long term aged R-value of 5 per inch, tested to ASTM C518. Compressive strength: Minimum 40 PSI, tested to ASTM D 1621. Foam compressive strength: Minimum 35 PSI, tested to ASTM D1621. Water absorption: Maximum 0.7 percent by volume, tested ASTM D2842. Water vapor permeance: 0.8, tested to ASTM E96/E96M. Provide the fllowing:

1. Product: “WallGUARD” Concrete Faced Insulated Perimeter Wall Panels or approved equal.

2. Manufacturer: T. Clear Corporation or approved equal.
   a. Board Size: 2 x 4 feet x 3-5/16 inches thick.
   b. Edges: Tongue-and-groove sides, square ends.

3. Accessories:

   a. Metal cap flashing: 24 gage stainless steel J-channel; 2-1/4 inches wide, 4 inch long leg and 2-1/4 inch short leg; prefinished, color to be selected.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 – GENERAL

1.01 SUMMARY

A. Products supplied under this section:
   1. Vapor barrier and installation accessories for installation under concrete slabs.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM E1745-17 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
   2. ASTM E1643-11 Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

B. Technical Reference - American Concrete Institute (ACI):
   1. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
   2. ACI 302.1R-15 Guide to Concrete Floor and Slab Construction.

1.04 SUBMITTALS

A. Quality control/assurance: In accordance with 01 3000
   1. Summary of test results per paragraph 9.3 of ASTM E1745.
   2. Manufacturer's samples and literature.
   3. Manufacturer's installation instructions for placement, seaming, penetration prevention and repair, and perimeter seal per ASTM E1643.
   4. All mandatory ASTM E1745 testing must be performed on a single production roll per ASTM E1745 Section 8.1.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Vapor barrier shall have all of the following qualities:
   1. Maintain permeance of less than 0.01 Perms [grains/(ft^2 · hr · inHg)] as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).

2. Other performance criteria:
    a. Strength: ASTM E1745 Class A.
    b. Thickness: 15 mils minimum
3. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1

B. Vapor barrier products:
1. Basis of Design: Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC., (877) 464-7834 www.stegoindustries.com.
2. Perminator 20 mil by W. R. Meadows, 800-342-5976.
3. Vaporguard 20 mil by Reef Industries, 713-507-4250
4. Moistop Ultra 20 mil by Fortifiber, (800) 773-4777

C. Accessories:
1. Seam Tape:
    a. Water Vapor Transmission Rate: ASTM E 96, 0.3 perms or lower
    b. Stego Tape by Stego Industries, 877-464-7834, or approved equal.
2. Mastic:
    a. Water Vapor Transmission Rate: ASTM E 96, 0.3 perms or lower
    b. Stego Mastic by Stego Industries, 877-464-7834, or approved equal.
3. Pipe Boots: STEGO® PRE-CUT PIPE BOOTS
4. Perimeter/edge seal:
    a. Stego Crete Claw
    b. Stego Term Bar
    c. StegoTack Tape (double-sided sealant tape)
5. Penetration Prevention: Beast Foot
6. Vapor Barrier-Safe Screed System: Beast Screed

PART 3 – EXECUTION

3.01 PREPARATION

A. Ensure that subsoil is approved by Architect or Geotechnical Engineer.
1. Level and compact base material.

3.02 INSTALLATION

A. Install vapor barrier in accordance ASTM E1643.
1. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
2. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site condition requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.
    a. Seal vapor barrier to the entire slab perimeter using Stego Crete Claw, per manufacturer's instructions.

OR

b. Seal vapor barrier to the entire perimeter wall or footing/grade beam with double sided StegoTack Tape, or both Stego Term Bar and StegoTack Tape, per manufacturer's instructions. Ensure the concrete is clean and dry prior to adhering tape.

3. Overlap joints 6 inches and seal with manufacturer's seam tape.
4. Apply seam tape/Crete Claw to a clean and dry vapor barrier.
5. Seal all penetrations (including pipes) per manufacturer's instructions.
6. For interior forming applications, avoid the use of non-permanent stakes driven through vapor barrier. Use blunt-end and/or threaded nail stakes (screed pad posts) and insert them into Beast Foot. Ensure Beast Foot's peel-and-stick adhesive base is fully adhered to the vapor barrier
7. If non-permanent stakes must be driven through vapor retarder, repair as recommended by vapor retarder manufacturer.
8. Use reinforcing bar supports with base sections that eliminate or minimize the potential for puncture of the vapor barrier.
9. Repair damaged areas with vapor barrier material of similar (or better) permeance, puncture and tensile.
10. For vapor barrier-safe concrete screeding applications, install Beast Screed (vapor barrier-safe screed system) per manufacturer's instructions prior to placing concrete.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Vapor Retarder Assembly, General: To perform as a continuous vapor impermeable barrier. Vapor retarder assemblies shall accommodate substrate movement and seal substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed vapor retarder, and transitions at perimeter conditions without deterioration and vapor leakage exceeding specified limits.

B. Material Performance: Provide materials which have an air permeance not to exceed <0.000012 L/(Pa·m2·s) when tested according to ASTM E2178.

C. Water Vapor Transmission: The water vapor transmission water method, (Procedure C) shall be determined in accordance with ASTM E96 and shall be declared by material manufacturer as follows:

1. Water vapor transmission shall be a maximum of 0.018 Perms when tested in accordance with ASTM E96 (desiccant method).

1.2 MATERIALS

A. Self-Adhering Sheet Membrane Vapor Retarder **[VRS-01]:** Self-adhesive SBS modified bitumen membrane, 31 mil thick, with a tri-laminated woven polyethylene facer.

B. Products:

1. “Vapor Retarder SA 31” (Sika).

2. “Sopravap’r” (Soprema)

3. “SA Vapor Retarder XL” (GAF)

C. Primer: Liquid waterborne primer recommended for substrate by manufacturer.

D. Joint Reinforcing Fabric and Strip: Manufacturer's standard reinforcement fabric or glass fiber mesh tape.

E. Transition Membrane: Manufacturer's standard vapor impermeable, self-adhering strip consisting of an adhesive coating over a impermeable laminate.

F. Detailing Membrane: Manufacturer's standard peel and stick membrane for installation between brackets for cladding support system. Membrane shall provide self-healing properties for post installed fasteners.

G. Substrate Patching Material: Manufacturer's standard trowel-grade substrate filler.

H. Adhesive and Tape: Manufacturer's standard adhesive and pressure sensitive adhesive tape.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Air and Water Barrier Assembly, General: To perform as a continuous vapor permeable air and water barrier and as a liquid water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air and water barrier assemblies shall accommodate substrate movement and seal substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed air and water barrier, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Material Performance: Provide materials which have an air permeance not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 0.3 inch water when tested according to ASTM E2178.

C. Water Vapor Transmission: The water vapor transmission water method, (Procedure B) shall be determined in accordance with ASTM E96 and shall be declared by material manufacturer as follows:

1. Water vapor transmission shall be a minimum of 5 grains/(h*sq. ft.*in Hg = 5 Perms when tested in accordance with ASTM E96 B (water method – unmodified).

2.02 MATERIALS

D. Fluid Applied, Vapor Permeable Membrane Air and Water Barrier **[ABS-01]:** Use regular, high temperature or low-temperature formulation depending on site conditions, within temperature ranges specified by manufacturer. Subject to compliance with requirements, provide one of the following.

1. GCP Applied Technologies “Perm-A-Barrier VPL 50”
2. Henry Company “Air-Bloc All Weather STPE”
3. Polyguard Products Inc. “AirLok STPE Spray-N-Roll”
4. Soprema “Sopraseal LM 204 VP”
5. Carlisle “Fire-Resist Barrithane VP”
6. DuPont “Tyvek Fluid Applied WB”

E. Primer: Liquid waterborne primer recommended for substrate by manufacturer.

F. Joint Reinforcing Fabric and Strip: Manufacturer's standard reinforcement fabric or glass fiber mesh tape.

G. Transition Membrane: Manufacturer's standard vapor permeable, self-adhering strip consisting of an adhesive coating over a permeable laminate.

H. Detailing Membrane: Manufacturer's standard peel and stick membrane for installation between brackets for cladding support system. Membrane shall provide self healing properties for post installed fasteners.

I. Substrate Patching Material: Manufacturer's standard trowel-grade substrate filler.

J. Adhesive and Tape: Manufacturer's standard adhesive and pressure sensitive adhesive tape.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 MATERIALS

A. Self-Adhering Sheet Membrane Roof Underlayment **[RS-01]:** Cold applied, self-adhering membrane composed of a high strength polyethylene film coated on one side with a layer of butyl rubber adhesive and interwound with a disposable release sheet. Provide an embossed, slip resistant surface on polyethylene.

1. Products:
   a. "Vycor Ultra" (CertainTeed).
   b. Or approved equal by Carlisle Co. or Polyguard Products.

2. Color: Gray-black.
3. Membrane Thickness: 30 mil ASTM D3767 method A.
4. Tensile strength, Membrane: 250 psi ASTM D412 (Die C modified).
5. Elongation, Membrane: 250% ASTM D412 (Die C modified).
6. Low Temperature Flexibility: Unaffected @ -20°F ASTM D1970.
7. Adhesion to Plywood: 3.0 lbs/in width ASTM D903.
8. Permeance (max): 0.05 Perms ASTM E96.
9. Material Weight Installed (max): 0.22 lb/ft2 ASTM D461.
10. Service Temperature: 300 degrees F per ASTM D1204.

B. Primer: As recommended by underlayment manufacturer for installed substrate.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.
2.

a)
b)

1)
2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 ROOF AND WALL PANELS

A. Standing Seam Metal Panel **[MTL-08]:** Weathering steel panels. ASTM A606 Type 4, smooth, interlocking fit at long edges, as follows:

1. Basis of Design: M.G. McGrath
2. Type: Standing Seam
3. Metal: Weathering Steel
4. Width: 16 inches
5. Thickness: 22ga

B. Perforated Standing Seam Metal Panel **[MTL-09]:** Weathering steel panels. ASTM A606 Type 4, smooth, interlocking fit at long edges, as follows:

1. Basis of Design: M.G. McGrath
2. Type: Standing Seam.
3. Metal: Weathering Steel, Perforated Metal with greater than 50% plus free-air.
4. Width: 16 inches
5. Thickness: 22ga

C. Flush Seam Metal Panel **[MTL-10]:** Weathering steel panels. ASTM A606 Type 4, smooth, interlocking fit at long edges, as follows:

1. Basis of Design: M.G. McGrath
2. Type: F-Seam
3. Metal Panel: Weathering Steel
4. Thickness: 16ga

D. Expanded Metal Panel **[MTL-11]:** Weathering steel panels. ASTM A606 Type 4, as follows:

1. Basis of Design: Amico Architectural Metals.
2. Type: APEX-03
3. Metal Panel: Weathering Steel.
4. Thickness: **TBD**

E. Flat Lock Metal Panel **[MTL-12]:** Weathering steel panels. ASTM A606 Type 4, smooth, interlocking fit at long edges, as follows:

5. Basis of Design: M.G. McGrath

6. Type: S-Slip
7. Metal Panel: Weathering Steel
8. Thickness: 16ga

F. Flashing and Trim: Provide panel system with closures, copings, corners, edge and joint covers, sill members, and similar items as required for complete installation. Fabricate of material and finish to match adjacent metal panels.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.
1.
2.
a)
b)
1)
2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 DESIGN AND PERFORMANCE REQUIREMENTS

A. Design Requirements:

1. General: Modified bituminous membrane roofing and base flashings and base flashing that when installed remain watertight; do not permit passage of liquid water; and withstands wind loads, building movement, thermally induced movement, and exposure to weather without failure.

2. Material Compatibility: Modified bituminous membrane roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

2.02 MANUFACTURERS

A. Roofing System **[RS-03]:** Provide bituminous membrane roofing system, including but not limited to bituminous membrane, flashing, edge lap sealant, substrate membrane adhesive, mastics, thinners, sealers, release agents, sheet activators, sheet primers and solvents; insulation board, insulation overlayment, sheathing, vapor barrier, membrane termination bars, vent and pipe clamping rings., fasteners and other accessories recommended by roof membrane manufacturer for a complete system.

B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Henry Company

2. Barrett Co.

3. Siplast, Inc.

4. Soprema Roofing and Waterproofing, Inc.

2.03 MODIFIED BITUMINOUS MEMBRANE ROOFING MATERIALS

A. SBS (Styrene Butadiene Styrene)-Modified Bituminous Sheet, Smooth Surfaced: ASTM D6164; SBS-modified asphalt sheet, smooth surfaced, dusted with fine parting agent on both sides; suitable for application method specified; manufacturer's standard thickness and weight; for use as the base ply of 2-ply, modified bituminous membrane roofing with woven or nonwoven polyester reinforcing mat.

B. SBS (Styrene Butadiene Styrene)-Modified Bituminous Sheet, Mineral-Granule Surfaced: ASTM D6164; SBS-modified asphalt sheet, with continuous layer of mineral granules factory applied to top exposed surface; suitable for application method specified; manufacturer's standard thickness and weight; for use as the finish ply of 2-ply, modified bituminous membrane roofing and base flashings with woven or nonwoven polyester reinforcing mat; color as selected from manufacturer’s standard colors.

2.04 AUXILIARY MATERIALS

A. Asphalt Primer: ASTM D41

B. Roofing Asphalt: ASTM D312, Type III or Type IV, as recommended by modified bituminous membrane manufacturer. Use Type IV for flashings. Label each container or provide certification with each load of bulk asphalt identifying type of roofing asphalt and indicating softening point, minimum flash point, equiviscous temperature, and finished blowing temperature.

C. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, 1- or 2-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with modified bituminous membrane roofing and flashings.

D. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required by roofing system manufacturer for application.

E. Mastic Sealant: Polyisobutylene, plain or modified bituminous, nonhardening, non-migrating, nonskinning, and nondrying.

F. Metal Flashing: Metal flashing is specified in Section 07 6000 "Sheet Metal and Flexible Flashing”.

G. Wood Nailer Strips: Furnish wood nailer strips complying with requirements of Section 06 1000 "Rough Carpentry."

H. Walkway Pads: Polymer-modified, reconstituted solid-rubber, surface-textured, slip-resisting pads, compatible with roofing system, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 1/2 inch thick, minimum. Pad Size: 2 ft. x 2 ft..

I. Other Auxiliary Membrane Materials: Furnish other auxiliary materials recommended by roofing system manufacturer for intended use and compatible with SBS-modified bituminous roofing.

2.01 FASTENERS

A. Fasteners: Stainless steel , factory coated galvanized steel or other corrosion resistant type complying with corrosion-resistance provisions of FM 4470; size, configuration, components and accessories as recommended and supplied by the single ply membrane manufacturer and approved by the insulation manufacturers designed for fastening base sheets, base-ply felts, and base flashings and for backnailing modified bituminous membrane to substrate; tested by manufacturer for required pullout strength. Fasteners

shall be capable of resisting a minimum pull-out force of 800 lbs. (3600N) when tested in accordance with ASTM E488. Provide fastener system equal to **FM Class 1-120 (confirm) wind uplift rating** and compatible with substrate, roofing membrane, adhesives and other products in contact with fastener.

B. Membrane Termination Bar: Roof membrane manufacturer approved, pre-drilled, extruded aluminum, stainless steel or flexible, weather and UV resistant plastic with splayed top to receive sealant bead; longest lengths available.

C. Pipe and Vent Clamping Rings: Roof membrane manufacturer approved, stainless steel adjustable wormgear pipe and vent clamping rings; size appropriate to installation.

2.01 INSULATION

A. Polyisocyanurate Board Insulation **[INS-02]:** Rigid insulation panel faced with 1/2 in. thick high density fiber board on the exterior side and fiber reinforced facer on both exterior and interior sides with core of preformed, rigid, cellular, polyisocyanurate thermal insulation complying with ASTM C1289, with aged r values of 6.0 at 75 deg F. for 1 in. thick board; At areas where tapered insulation is scheduled, provide first layer insulation board without the high density fiber board. Provide one of the following:

1. “ENRGY 3 PLUS” (Johns Manville)

2. “ACFoam Composite” (Atlas Roofing Corporation)

3. “EnergyGuard Polyiso Insulation Board” (GAF Materials Corporation)

B. Tapered (if required) Polyisocyanurate Board Insulation **[INS-02]:** Rigid insulation panel faced with 1/2 in. thick high density fiber board on the exterior side and fiber reinforced facer on both exterior and interior sides with core of preformed, rigid, cellular, polyisocyanurate thermal insulation complying with ASTM C1289, with aged r values of 6.0 at 75 deg F. for 1 in. thick board. Provide preformed, tapered insulation boards, preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated on the drawings for sloping to drain. Provide one of the following:

1. "ENRGY 3 PLUS " and "Tapered ENRGY 3"(Johns Manville)

2. "ACFoam Composite " and "Tapered ACFoam Composite" (Atlas Roofing Corporation)

3. "EnergyGuard Polyiso Insulation Board" and "EnergyGuard Tapered Polyiso Insulation Board" (GAF Materials Corporation).

C. Metal Roof Deck Overlayment Board: "Dens-Deck Fireguard Type X"(Georgia-Pacific Corporation); Non-structural, fiberglass faced gypsum panel with core composed of a silicone-treated water-resistant gypsum core and fiberglass mats; 5/8 in. thick, unless otherwise indicated.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 DESIGN AND PERFORMANCE REQUIREMENTS

A. General Provide flashing materials that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Compatibility: Provide only flashing materials and accessories which are explicitly recommended by the manufacturer for the application, and which have been determined by tests to be totally compatible with contiguous surfaces and each other.

2.02 SHEET METAL FLASHING MATERIALS

A. Stainless Steel Sheet Flashing **[FLH-01]:** ASTM A666, Type 304, dead soft fully annealed except where harder temper required for forming or performance; 0.015 in. thick (28 gage) unless otherwise shown or specified, finish No. 2D.

2.03 FLEXIBLE FLASHING MATERIALS

A. Neoprene Flexible Flashing **[FLH-02]:** Uncured black neoprene synthetic rubber, red lead curative, formed into uniform flexible sheets not less than 1/16 in. thick, by required width. Provide one of the following:

1. "Hydrotech Flex-Flash UN" (American Hydrotech, Inc.).

2. "GacoFlex NF-621" (Gaco Western, Inc.).

3. "Ram-Flash 327 H.D. (uncured)" (The Barrett Co.).

4. "Neoflash" (Henry Company).

B. Silicone Flexible Flashing **[FLH-03]:** Preformed, heat cured, silicone elastomer formed into uniform flexible sheets not less than 1/16 in. thick, by required width. Color as selected by the Architect. Provide one of the following:

1. "123 Silicone Seal" (Dow Corporation).

2. "UltraSpan Weatherstrip" (GE/Momentive Silicones).

2.04 PREFABRICATED FLASHING SYSTEM

A. General: The flashing closure systems specified herein by proprietary designation prefabricated flashings for column, pipe and other penetrants as manufactured by SBC

Industries and establish the quality standards required for these systems. Equivalent products of other manufacturers will be considered provided they meet those established standards. Fabricated from 26 gauge stainless steel type 304, with 2B finish, complying with ASTM A240, and in strict compliance with manufacturer's fabrication requirements.

1. Large Pipes:

   a. Either “PL/D 2 Piece Divided System” or “PL/S 1 Piece Slip-On System” (SBC Industries).

2. Small Pipes:

   a. Either “CD-PD 2 Piece Divided System” or “CS-PS 1 Piece Slip-On System” (SBC Industries).

3. Column, Angles, Channels, Square Tubing and Beam Flashings:

   a. “AA/D, H/D, CH/D, SQ/D” (SBC Industries).

4. Custom Shapes: Provide custom shaped flashings for penetrants as shown or required formed to shape of penetrating elements, and counter flashed as required by manufacturer's specifications, recommendation and instructions to provide a water-proof, air tight system.

B. Provide prefabricated flashing systems as manufactured by one of the following:

1. SBC Industries

2. Artis Metals

3. Menzies

2.05 SHEET METAL FLASHING - AUXILIARY MATERIALS

A. Solder for Stainless Steel: ASTM B32; provide 60% - 40% tin/lead solder, with acid chloride type flux, except use rosin flux over tinned surfaces.

B. Fasteners: Screws, rivets and nails shall be non-corrosive, of same material as sheet metal flashing and trim or compatible material. Match finish of exposed heads with material being fastened

C. Metal Accessories: Provide sheet metal clips, cleats, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance

D. Sealant: As specified in Section 07 9000 “Joint Sealants”.

E. Foam Tape: ASTM D-1056; closed cell foam, PSA on one side, 1/4 in. or 3/8 in. x 1 in. wide.

F. Epoxy Seam Sealer: 2 part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior nonmoving joints including riveted joints

G. Mastic Sealant: Polyisobutylene; nonhardening, non-skinning, non-drying, nonmigrating sealant.

2.06 FLEXIBLE FLASHING - AUXILIARY MATERIALS

A. Adhesives

1. Neoprene Flexible Adhesive: Type recommended by neoprene flexible flashing manufacturer for waterproof/weather resistant seaming and adhesive application of flexible flashing and compatible with materials to which it is bonded to and in contact with. Provide appropriate color of adhesive to prevent staining of substrates.

2. Silicone Flexible Adhesive: Silicone sealant adhesive, type recommended by silicone flexible flashing manufacturer for waterproof, weather resistant seaming and adhesive application of silicone flexible flashing and compatible with materials to which it is bonded to and in contact with. Provide appropriate color of adhesive to prevent staining of substrates.

B. Flexible Flashing Filler: Closed cell polyethylene or other soft closed cell material recommended by flexible flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

C. Primer, Cleaners and Sealant: As recommended by the flexible flashing manufacturer and compatible with the materials to which it is bonded.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 DESIGN AND PERFORMANCE REQUIREMENTS

A. Performance Requirements

1. General Performance: Roof and wall specialties and accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2. Loading Criteria: Design, fabricate and install roof and wall accessories to withstand the inward and outward wind loads, live loads, building movement, and wind uplift **(min. 30 psf)** loads.

3. Temperature Requirements: Design, fabricate and install component parts to provide for expansion and contraction over an ambient temperature range of **120 deg. F.** and a surface temperature range of **180 deg. F.** without buckling, sealed joint failure, undue stress on members or anchors, and other detrimental effects.

4. Watertightness: Provide tight joints and effectively seal roof and wall specialties and accessories against water leakage and air infiltration. Water leakage is defined as the appearance of uncontrolled water, other than condensation, on any inboard part of a roof and wall specialty or roof and wall accessory.

5. Design Modifications: Make design modifications of work shown only as may be necessary to meet performance requirements and coordinate the work. Variations in details and materials which do not adversely affect appearance, durability or strength shall be submitted to the Architect for review.

2.02 MATERIALS

A. Gutters **[MFAB-05]:** Stainless Steel Sheet: ASTM A240, Type 304L. Minimum 24 ga. (0.64 mm) thickness. No. 2D conventional annealed finish. Fabricate sections in lengths to minimizes seams. Join sections with flat-locked seams formed in direction of water flow and sealed. Join roofing to gutter by similar flat lock seam. Provide a complete and continuous waterproof installation.

1. Shape and Configuration: As indicated on drawings.

B. Snow Guard System **[SNG-01]:** Provide painted aluminum rail and stainless steel clamp system. Provide a complete system as indicated on drawings.

1. Shape and Configuration: As indicated on drawings.

2. System Description:

    a. Attachment system to provide attachment to standing seam metal roofs:

        1) With dimpling deformation of panel seams only at setscrew locations.
        2) Without penetrations through roof seams or panels.
        3) Without use of sealants or adhesives.
        4) Without violation of roof warranty.

    b. Attachment system to provide attachment to metal roofs:

        1) Without use of sealants or adhesives.

3. Performance Requirements: Provide snow guard system to withstand exposure to the weather and environmental elements and resist design forces without failure due to defective material or manufacture.

    a. Loading: Design snow guard system to resist minimum design roof snow load(s) per project roof design snow load **[of __.]**

    b. Factor of Safety: Utilize a factor of safety **[2]** to determine allowable loads from ultimate tested clamp tensile mean load values.

4. Source Limitation: Provide snow guard system as designed and tested by the manufacturer as a complete system. Install all system components by the same manufacturer.

5. Manufacturer:

    a. Basis of Design: “S-5 ColorGuard 2.0” (Metal Roof Innovations).

    b. Or approved equal from the following manufacturers:

        1) LMCurbs.
        2) Rocky Mountain Snow Guards Inc.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for furnishing and installing firestopping for fire-rated construction. Contractor is responsible for identifying various conditions requiring firestopping material and for submitting proposed UL Tested Assemblies for Architects review.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.
   1. Material Safety Data Sheets: Submit MSDS for each firestop products.
   2. Shop Drawings: Show typical installation details for methods of installation. Indicate which firestop materials will be used where and thickness for different hourly ratings.
   3. Installer Documentation: Submit document from Firestop Manufacturer wherein Manufacturer recognizes, i.e. approves installer for said Manufacturer's Firestop products.
   4. Prepare job mock-up of the material proposed for use in the project as directed by Architect. Approved mock-ups may be left in place as part of the finished project and will constitute the standard for remaining work, including aesthetics.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Firestopping materials shall conform to Flame (F) and Temperature (T) ratings as required by local building code and as tested by nationally accepted test agencies per ASTM E 814 or UL 1479 fire tests. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating, when required by code authority, shall be based on measurement of the temperature rise on the penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.

B. Firestopping material shall be asbestos free and free of any PCBs.

C. Do not use any product containing solvents or that requires hazardous waste disposal.

D. Do not use Firestop Products which after curing, dissolve in water.

E. Firestopping shall be performed by a contractor trained or approved by Firestop Manufacturer.

F. 3RD Party Special Inspections per Building Code Section 1704 are required to be provided for work under this Section.

1.05 PRODUCT DELIVERY, STORAGE AND HANDING

A. Deliver material in the manufacturers' original, unopened containers or packages with manufacturer's name, product identification, lot numbers, UL-labels, and mixing and installation instructions, as applicable.

B. Store materials in the original, unopened containers or packages, and under conditions recommended by manufacturers.

C. All Firestop materials shall be installed prior to expiration of shelf life.

1.06 PROJECT CONDITIONS

A. Conform to Manufacturer's printed instructions for installation and when applicable, curing in accordance with temperature and humidity. Conform to ventilation and safety requirements.

1.07 WARRANTY

A. Firestop Contractor shall warranty that firestopping systems used meet firestopping requirements as herein specified.

1.08 SEQUENCING

A. Coordinate this work as required with work of other trades.

B. Firestopping shall precede gypsum board finishing.

1.09 PROTECTION

A. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide materials from one of the following manufacturers:
   1. Hilti
   2. Cafco
   3. STI
   4. 3M
   5. Approved Equal.

2.02 MATERIALS

A. Provide mortars, sealants, caulks, putty, collars, pillows, wrap strips, composite sheets and related materials as required by the UL Design Assembly proposed for each individual application.

B. Accessories:
   1. Forming/Damming Materials: Mineral fiberboard or other type recommended by manufacturer.
   2. Primer, Sealant and Solvent Cleaner: As recommended by manufacturer.

C. Seal all penetration of sound isolating construction with non-hardening material.

2.03 SAFING INSULATION

A. Provide Thermafiber semi-rigid product compling with ASTM C665, Type I; minimum density of 4.0 pcf; passing ASTM E136 for combustion characteristics and with Fire Hazard Classification when tested according to ASTM E84; flame spread of 15 or less, fuel contribution of 0 and smoke development of 0.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions where Firestops are to be installed and notify the architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the architect.

B. Verify that environmental conditions are safe and suitable for installation of Firestop product(s).

3.02 CONDITIONS REQUIRING FIRESTOPPING

A. General:
   1. Provide firestopping for conditions specified whether or not firestopping is indicated, and, if indicated, whether such material is designated as insulation, safing, or otherwise.

2. Insulation types specified in other Sections shall not be installed in lieu of firestopping material specified herein.

B. Building Exterior Perimeters:
1. Where exterior facing construction is continuous past a structural floor, and a space would otherwise remain open between the inner face of the wall construction and the outer perimeter edge of the structural floor, provide firestopping to equal the fire resistance of the floor assembly. Mineral wool by itself is not an acceptable firestop, neither is mineral wool used with beads of caulking applied along length of mineral wool/curtain wall or mineral wool/floor slab junctures. If mineral wool is part of firestop system, the mineral wool must be completely covered by appropriate thickness of UL listed Firestop Sealant.
2. Firestopping shall be provided whether or not there are any clips, angles, plates, or other members bridging or interconnecting the facing and floor systems, and whether or not such items are continuous.
3. Where an exterior wall of composite type construction passes a perimeter structural member, such as a girder, beam, or strut, and the finish on the interior wall face does not continue up too close with the underside of the structural floor above, thus interrupting the fire-resistive integrity of the wall system, and a space would otherwise remain open between the interior face of the wall and the lower edge of the structural member, provide firestopping to continuously fill such open space.

C. Interior Walls and Partitions:
1. Where a wall or partition is continuous past a structural floor, such as at stairwells and vertical shafts, and a space would otherwise remain open between the wall face and perimeter edge of the adjoining structural floor, provide firestopping.
2. Provide firestopping whether or not there are any clips, angles, plates, or other members bridging or interconnecting the wall and floor systems, and whether or not such items are continuous.
3. Where the top edge of a fire-rated wall or partition abuts and is at right angle to fluted-type metal decking, and the construction is such that would otherwise leave the flute spaces open, provide firestopping.
4. Where the bottom track or plate of a partition meets the concrete slab provide firestopping sealant.
5. Where the bottom track or plate of a partition meets the top of the concrete block wall below the drywall partition provide firestopping sealant.

D. Penetrations:
1. Penetrations include conduit, cable, wire, pipe, duct, electrical boxes, fire extinguisher cabinets, toilet accessories or other elements which pass through or penetrate one or both sides of a fire rated floor, wall, or partition.
    a. If "5 sided" gypsum board enclosures are omitted where metal electrical back boxes not exceeding 16 square inches occur at one side only of a wall within a single stud cavity; provide fire stopping material described in this Section to completely encompass the back box and its annular space.
2. Except for floors on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof, provide firestopping to fill such spaces in accordance with ASTM E 814.

3. Where penetrations occur at fire-rated walls or partitions of solid-type construction, provide firestopping to completely fill spaces around the penetration, in accordance with ASTM E 814.
4. Where penetrations occur at fire-rated walls or partitions of hollow-type construction, provide firestopping to completely fill spaces around the penetration, on each side of the wall or partition, in accordance with ASTM E 814.
5. These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved, firestop annular space - if any - between sleeve and wall of opening.

E. Provide firestopping to fill miscellaneous voids and openings in fire-rated construction in a manner essentially the same as specified above.

3.03 INSTALLATION

A. General:
1. Installation of Firestops shall be performed by applicator/installers qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
2. Apply Firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
3. Coordinates with plumbing, mechanical, electrical and other trades to assure that all pipe, conduit, cable, and other items which penetrate fire related construction have been permanently installed prior to installation of Firestops, schedule and sequence the work to assure that partitions and other construction which would conceal penetrations are not erected prior to the installation of Firestops.
4. At gypsum board fire walls the entire gap between the floor slab up to the bottom edge of the gypsum board is to be filled 100% and continuous.

B. Dam Construction: Install dams when required to properly contain Firestopping materials within openings and as required to achieve required fire resistance rating. Combustible damming material must be removed after appropriate curing. Incombustible damming materials may be left as a permanent component of the Firestop system.

C. Field Quality Control:
1. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
2. Follow safety procedures recommended in the Material Safety Data Sheets.
3. Finish surfaces of firestopping which is to remain exposed in the completed work to a uniform and level condition.
4. All areas of work must be accessible until inspection by the applicable Code authorities.
5. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.

3.04 CLEANING

A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.

B. Leave finished work in neat, clean condition with no evidence of spillovers or damage to adjacent surfaces.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish labor, materials, tools, and equipment required to completely close (with caulking compound or sealant) all joints to give a finished appearance. Items to be caulked or sealed include but are not limited to the following:
   1. Hollow metal frames.
   2. Exterior doors, louvers, windows and any other openings in exterior walls.
   3. Plumbing fixtures.
   4. Flooring, paving and sidewalk joints.
   5. Joints shown on drawings or specified to be caulked or sealed.
   6. All joints or gaps between similar or dissimilar materials that do not receive closure trim are to be caulked/sealed with the appropriate material as listed in Part 2 of this Section.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Qualifications of Applicators: Use workmen thoroughly skilled and specially trained in techniques of caulking, and completely familiar with manufacturer's published recommendations for caulking material used.

B. Rejection of Installed Caulking: Lack of skill by caulking installers is sufficient ground for Architect to reject installed caulking and to require its removal and complete recaulking at Contractor's expense.

C. Guarantee: Guarantee caulking materials and workmanship, in writing for 2 years after substantial completion date. Repair at Contractors expense any defects developing within guarantee period.

D. Submit manufacturer's product data sheets and color selection information for every brand and type of sealant, caulk and accessory item proposed for use on this project.

1.05 PRODUCT HANDLING

A. Protection: Protect caulking materials before, during, and after installation. Protect installed work and materials of other trades. In event of damage, immediately make repairs and replacements necessary at Contractor's expense.

B. Storage: Store caulking materials and equipment under conditions recommended by manufacturer. Do not use materials stored for period of time exceeding maximum recommended material shelf-life.

1.06 JOB CONDITIONS

A. Inspection: Carefully inspect installed work of trades and verify work is complete to point where this installation may properly commence.

B. Discrepancies: Do not proceed with installation in areas of discrepancy until discrepancies are fully resolved.

C. Do not install sealants under adverse weather conditions, or when temperatures are not within manufacturer's recommended limitations for installation. Install sealants only when forecasted weather conditions are favorable for proper care and development of high early bond strength.

PART 2 - PRODUCTS

2.01 MATERIALS FOR CAULKING AND SEALING

A. Select caulking materials for specific locations complying with manufacturers recommendations. Provide caulking, sealant and accessory items in color(s) selected to match adjacent materials or as selected by Architect from manufacturer's complete line.

B. VOC Content Of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Architectural Sealants: 250 g/L.
   2. Sealant primers for Nonporous Substrates: 250 g/L.
   3. Sealant primers for Porous Substrates: 775 g/L.

C. Silicone Sealant: Single component, non-sag, gun grade product meeting ASTM C920, Type S, Grade NS, Class 25.
   1. Silicone Sealant 790/791/795 by Dow-Corning Corp.
   2. Sonolastic-OmniPlus by BASF.
   3. Silpruf SCS2000 by GE

D. Silicone Sealant for Weather Barrier Membranes: Refer to Weather Barrier specification and provide Dow Corning 758 Silicone Weather Barrier Sealant.

E. For soft joints adjacent to Architectural Precast Concrete and Cast Stone products, use Single-Component, Nonsag, Non-Staining, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, Use NT.
   1. Silicone Sealant 756 SMS by Dow-Corning Corp.
   2. Tremco, Inc., Spectrum 3

F. Mildew-Resistant Silicone Sealant: Single component, non-sag, gun grade product meeting ASTM C920, Type S, Grade NS, Class 25.
   1. Silicone Sealant 786 by Dow-Corning Corp.
   2. Sanitary 1700 by GE
   3. Tremsil 200 Sanitary by Tremco

G. Acrylic Latex Caulk (interior only): General purpose, gun grade, nonsag, paintable, nonstaining latex sealant complying with ASTM C834.
   1. Sonolac by Sonnoborn.
   2. AC-20 + Silicone by Pecora.
   3. Tremflex 834 by Tremco.

H. Acoustical Sealant: General purpose, gun grade, nonsag, paintable, nonstaining latex sealant complying with ASTM C834.
   1. SHEETROCK Acoustical Sealant by U.S. Gypsum
   2. AC-20 FTR by Pecora
   3. Acoustical Sealant GSC by Grabber Construction Products
   4. Acoustical Sealant by Tremco

I. Polyurethane Sealant (for vertical surfaces): Single component, non-sag, gun grade product meeting ASTM C920, Type S, Grade NS, Class 25.
   1. MasterSeal NP-1 by Master Builders.
   2. Vulkem Dymonic FC by Tremco
   3. Dynatrol I by Pecora.
   4. QSC-102 by Carlisle.

J. Polyurethane Sealant (for horizontal surfaces): Single component, non-priming, self leveling, pourable grade product meeting ASTM C920, Type S, Grade P, Class 25.
   1. MasterSeal SL-1 by Master Builders.
   2. Vulkem 45SSL by Tremco
   3. NR-201 by Pecora.
   4. QSC-131 by Carlisle.

2.02 SEALANT BACKER RODS

A. Sealant Backer Rod for general use except at floor and deck joints: Open cell type as recommended by sealant manufacturer for compatibility with sealant.

B. Sealant Backer Rod for use at floor and deck joints: Closed cell type as recommended by sealant manufacturer for compatibility with sealant.

C. Provide rod sized and shaped to control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backer to minimize possibility of sealant extrusion when joint is compressed.

2.03 MISCELLANEOUS MATERIALS

A. Joint Cleaner Compound: Use type recommended by sealant and caulking compound manufacturer for joint surfaces to be cleaned.

B. Joint Primer/Sealer: Use type recommended by sealant manufacturer for joint surfaces to be primed or sealed.

C. Bond Breaker Tape: Use self adhesive polyethylene tape or plastic tape recommended by sealant manufacturer. Apply to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant.

D. Joint Filler: W.R. Meadows, Sealtight Standard Cork, Expansion Joint Filler produced from clean, selected, granulated cork bonded with a phenolic resin, or approved equal meeting ASTM D 1752, Type II.

2.04 GENERAL APPLICATION GUIDE

A. Interior caulking, except joints with ceramic tile, metal, glass and aluminum: Acrylic Latex Caulk.

B. Sound rated walls, partitions and ceilings: Acoustical Sealant.

C. Interior and Exterior joints with metal, glass and aluminum: Silicone sealant.

D. Joints with ceramic tile and plumbing fixtures: Mildew resistant Silicone sealant.

E. Horizontal and Vertical building joints: Polyurethane sealant.

F. Paving Joints: Refer to Division 32

PART 3 - EXECUTION

3.01 CHOICE OF CAULKING MATERIAL

A. Use sealant and caulking materials best suited to the installation and recommended by caulking material manufacturer.

3.02 INSPECTION

A. Installer must examine substrates, (joint surfaces) and conditions under which joint sealer work is to be performed. Do not proceed with joint sealer work until unsatisfactory conditions are corrected.

3.03 JOINT PREPARATION

A. Clean joint surfaces immediately before installation of gaskets, sealants and caulking compounds. Remove dirt, insecure coatings, moisture and substrates which could interfere with gasket seal and bond of sealant or caulking compound.

B. Prime or seal joint surfaces where required, and when recommended by sealant manufacturer. Confine primer/sealer to areas of sealant bond. Do not allow spillage and migration onto adjoining surfaces.

3.04 INSTALLATION

A. Comply with manufacturer's printed instructions except when more stringent requirements are specified, and except when manufacturer's technical representative directs otherwise.

B. Set joint filler units at depth and position in joint as required to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.

C. Install sealant backer rod except when required to be omitted or recommended to be omitted by sealant manufacturer for application required.

D. Install bond breaker tape when required by manufacturer's recommendations to ensure liquid-applied sealants will perform as intended.

E. Employ proven installation techniques, which ensure sealants are deposited in uniform, continuous ribbon without gaps or air pockets, and with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise required, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints occur between a horizontal surface and vertical surface, fill joint to form a slight cove, so joint will not trap moisture and dirt.

F. Install liquid-applied sealant to depths required and as recommended by sealant manufacturer.

G. Spillage: Do not allow sealants and compounds to overflow from joint confines or to spill onto adjoining work, or to migrate into voids of exposed finished. Clean adjoining surfaces to eliminate evidence of spillage without damaging adjoining surfaces.

H. Recess edges of exposed joint fillers slightly behind adjoining surfaces, unless otherwise required, so compressed units will not protrude from joints.

I. Acoustical Sealant Application: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

1. Where sound rated walls and partitions are penetrated by pipe, conduit, duct, etc.; pack annular space with acoustical fiberglass insulation until flush with both faces of wall. Seal both sides and the entire annular space between the penetrating item and the wall board with acoustical sealant. Also, seal at top and bottom edges of

acoustical walls and partitions where wall board abuts a horizontal surface. Joint is to be full and continuous from slab to gypsum board edge at bottom of gypsum board walls.

2. Do not allow any rigid material or connection to bridge the separation between the acoustical construction and the penetrating item. Upon inspection, if bridging is found to exist, all sealed penetrations may be ordered removed and resealed at Contractor's expense.

3.05 CURE AND PROTECTION

A. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Cure and protect sealants in manner which will minimize increases in modules of elasticity and accelerated aging effects.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. General: Provide exterior enclosure in accordance with requirements of the Contract Documents.

B. The Contractor awarded the Exterior Enclosure Work shall be responsible for the engineering, detailing, fabrication and erection of the complete Exterior Enclosure Systems. The Work shall include all labor, materials, tools, equipment, protection, testing and engineering services required to manufacture, deliver, furnish and install all items necessary for the proper execution and completion of the Work, as shown on the Drawings and as specified herein and/or as otherwise required to provide a complete, code-complying and warranted installation.

1.2 REFERENCES

A. General: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict between referenced standards, this specification or within themselves, the more stringent standard or requirement shall govern.

1. American Architectural Manufacturers Association (AAMA): AAMA "Curtain Wall and Design Guide Manual ".

2. Aluminium Association (AA)

    a. Aluminum Standards and Data
    b. Designation System for Aluminum Finishes
    c. Engineering Data for Aluminum Structures

3. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM "Metal Finishes Manual".

4. American Society for Testing and Materials (ASTM): ASTM C1401 “Standard Guide for Structural Sealant Glazing”.

5. American Welding Society AWS

    a. AWS D1.1 "Structural Welding Code - Steel".
    b. AWS D1.2 "Structural Welding Code - Aluminum".
    c. AWS D1.3 "Structural Welding Code - Sheet Steel".
    d. AWS D1.6 “Structural Welding Code – Stainless Steel.”

6. Air Movement and Control Association, Inc. (AMCA): AMCA Standard 500-L "Laboratory Methods of Testing Louvers for Rating".

7. National Fenestration Ratings Council (NFRC)

   a. NFRC 100 "Procedure for Determining Fenestration Product U-Factors
   b. NFRC 200 "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence".

8. National Fire Protection Association (NFPA)

   a. NFPA 285 "Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components".

1.3 SYSTEM DESCRIPTION

A. Design Requirements: The exterior enclosure system as described herein is that portion of the facade that comprises materials, components and assemblies between the internal and the external surfaces, installed in conjunction other specified facade elements, will produce a complete building "façade" which shall be considered a complete system providing a high quality, watertight, airtight and structurally sound enclosure to the specified standards. Drawings and details are diagrammatic and are intended to show design concept, configuration, components and arrangements; they are not intended to identify nor solve completely problems of thermal and structural movements, air pressure equalization, air and vapor barriers, assembly framing, fixings and anchorages, moisture disposal, water penetration and problems at the glass line associated with glazing installation, movements, pressure fracture or thermal shock and weather seal. Final engineering design of exterior enclosure is responsibility of this trade. Material types, sizes and/or thicknesses shown on Drawings are minimums acceptable and shall not be reduced regardless of engineering design. The work of this Section includes, but is not limited to, the following

   1. Metal exterior enclosure components including finish coatings.

   2. Metal trim as may be necessary to join adjoining materials to the metal and glass assemblies including finish coatings.

   3. Metal copings, counter flashings, fascias and integrated metal panels necessary to produce water tight parapets including finish coatings complete with anchors and brackets.

   4. Metal fascias, soffits, architectural features, access panels, access doors, access windows, etc. and hardware miscellaneous trim and accessories including finish coatings.

   5. Glass, glazing and accessories associated with the metal and glass exterior building enclosure.

6. Metal panels infill panels, spandrels, shadow boxes and trim in designated portions of the facade including finish coatings.

7. Finished interior sill and head trim including metal closure from the interior of curtain wall to the top of slab as backing to interior floor finishes.

8. Insulation and vapor barrier within the exterior portion of the facade.

9. Out-of-sequence infill areas and overlaps with other trades as defined and coordinated by Construction Manager.

10. Fire separation insulation and firestopping, including smoke seals, at the junction of slab edges and elsewhere within the aluminum and glass portion of the facade and including the necessary galvanized sealed smoke stops and other accessories associated with the system.

11. Reinforcing (stiffeners, brackets,) required to strengthen or reinforce members that are not specifically called out as structural steel or miscellaneous metal fabrications.

12. Sealants, joint fillers, gaskets, necessary to produce a watertight installation including sealants and joint fillers at the junction of the aluminum and glass elements, stonework and contiguous facade components.

13. Weeps, baffles, thermal breaks, flashings, necessary to meet performance requirements.

14. Anchors, inserts, embedded devices, necessary to support the exterior enclosure system. This shall include but not be limited to design, engineering, coordination, manufacture, supply, layout, monitoring and field checking, installation and necessary repair of the exterior enclosure fixing anchors and their attachment to the embedded anchorage and the anchorage embeds.

15. Metal louvers (and associated insulated blank-off panels and splash pans) occurring within the field of exterior enclosure construction including finish. Provide flanges around active louver areas drained to exterior to accept ductwork and plenum closures.

16. Coordination with other trade contractors that have components of their work installed on or within the exterior enclosure system.

17. Shop drawings, structural calculations, manufacturer's data, certifications of compliance and selected samples of materials and warranties pertaining to the exterior building enclosure.

18. Construction of full size visual mock-ups and mock-ups for performance testing.

19. Testing of mock-up(s) at independent testing laboratory approved by the Owner including coordination of testing and testing procedures with the selected

laboratory and payment of laboratory fees.

20. Quality assurance/control testing and inspection work not otherwise specifically assigned to others.

21. Field measurements of adjacent and/or supporting construction and verification of existing conditions.

22. Field testing of assemblies for water penetration.

23. Protection including protective film and removal of same film and cleaning of finished work (both interior and exterior surface of exterior enclosure systems).

24. Participation in coordination meetings throughout the course of the Work.

25. Preparation of "as-built" shop drawings reflecting changes (from original "approved" shop drawings) that may have occurred during construction and testing of the performance mockup or the course of the work.

26. "Attic Stock" of glass.

B. Performance Requirements

1. General:

a. The Exterior Enclosure system as described in this Section is that portion of the exterior enclosure comprised of materials, components and assemblies between the internal and external surfaces, installed in conjunction with other specified façade and roofing elements, to produce a complete building enclosure, which shall be considered a complete system providing a high-quality, watertight, airtight and structurally sound enclosure to the specified standards. Drawings and details are diagrammatic and are intended to show design concept, configuration, components and arrangements; they are not intended to identify nor solve completely problems of thermal and structural movements, air pressure equalization, air and vapor barriers, assembly framing, fixings and anchorages, moisture disposal, water penetration and problems at the glass line associated with glazing installation, movements, pressure fracture or thermal shock and weather seal. Material types, sizes and/or thicknesses shown on Drawing are minimums acceptable and shall not be reduced regardless of engineering design.

2. Wind Load Capacity

a. Cladding pressures to be determined local Building Code requirements and if necessary, by laboratory wind tunnel testing to be commissioned by Owner.

b. The completed Exterior Enclosure shall withstand the inward and outward pressures normal to the plane of the wall. At corners and other changes in plane, both surfaces shall be assumed to experience the most severe combinations of negative and positive pressures simultaneously.

3. Structural

a. Maximum Deflections Normal to the Wall

1) For spans up to 13'-6", lesser of **TBD** *(L/175 of clear span of the component part or ¾ inch, except limit maximum center-of-glass deflection to 1 inch, and deflection of the entire assembly including glass to 1-1/2 inches*).

2) For spans greater than 13'-6" and up to 40'-0", lesser of **TBD** *(L/240 of clear span of the component part or 1-1/2 inches, except limit maximum center-of-glass deflection to lesser of L/100 or 1 inch, and deflection of the entire assembly including glass to 2 inches).*

3) Deflection of cantilevered elements at full design wind pressure (e.g. parapets or framing members overhanging anchor points), shall not exceed **TBD** *(lesser of 1% of cantilever length or ¾ inch).*

4) For Exterior Metal Panels, Fascia, Metal Covers, or Other Fabricated Metal Items: Lesser of **TBD** *(L/120 of clear span or ¾ inch. Deflection shall be measured relative to the horizontal and vertical support members with the allowable deflection being determined by the lesser dimension).*

5) For exterior louvers, **TBD** (*L/180 of clear span*).

4. Building Movements

a. Exterior Enclosure system to withstand building movements including loading deflections, shrinkage, creep, seismic and similar movements. Design for simultaneous occurrence of all specified movements. No reductions shall be applied to individual movements or combinations of movements.

5. Temperature Requirements

a. Design, fabricate and install component parts to provide for vertical and horizontal expansion and contraction of the exterior enclosure over an ambient exterior temperature range and exterior metal surface temperature of **TBD** *(-20 degrees F. through +180 degrees F),* and an interior temperature range of **TBD** *(+55 degrees F. to 120 degrees F.)* without buckling, sealed joint failure, glass breakage, undue stress on members or anchors, or other detrimental effects.

6. Snow and Ice Loading

    a. Snow and Ice Loading will be determined in accordance with ASCE-7-22 and, if necessary, laboratory analysis to be commissioned by Owner. Information will be used to develop specific loading criteria for individual components in the exterior enclosure systems.

7. Insulation Barrier

    a. Design, fabricate and install exterior enclosure work with an integral continuous insulation barrier and vapor barrier to provide an insulated exterior enclosure system.

    b. The thicknesses shown on the drawings is the minimum effective thickness for the insulation barrier. Provide additional insulation thickness to compensate for losses in insulation value due to wall support configuration, gaps and tolerances between wall panels and other wall assembly components.

8. Condensation Requirements

    a. Design, fabricate, and install the exterior enclosure to prevent excessive condensation on the indoor face with the building heating and ventilating system in normal operation. Excessive condensation is defined as visible water, ice or frost on more than 5% of the area of module of the exterior enclosure, visible in the final construction or the accumulation of uncontrolled condensation flowing from the exterior enclosure.

9. Fire Propagation Characteristics

    a. Provide exterior wall assemblies that contain combustible components complying with NFPA 285 and per local Building Code.

10. Fire, Smoke, and Draft Barrier

    a. Perimeter Fire Stopping: A continuous fire / smoke / draft barrier complying with ASTM E2307 to be provided as an integral component of the exterior wall systems to prevent the passage of air, flame and smoke from one floor to another, within the exterior wall work.

11. Exterior Vertical Enclosure Glazed Assemblies Performance Criteria

    a. Thermal Resistance

        1) The U-factors of fenestration products shall be determined in accordance with NFRC 100, and criteria per local Building Code.

    b. Water Resistance

1) No water penetration shall be permitted at the differential static pressure of 15 psf, except at exterior swing doors.

2) For out-swinging exterior and sliding doors, no water penetration shall be permitted at the differential static pressure of 12 psf.

c. Air Infiltration Resistance

1) Air infiltration shall not exceed 0.06 cfm/ft2 of wall area when tested at 6.24 psf test pressure.

2) For out-swinging exterior doors, provide air infiltration resistance per AAMA "AW-50" performance class.

d. Solar Heat Gain Coefficient

1) The solar heat gain coefficient (SHGC) of glazed fenestration products shall be determined in accordance with NFRC 200 and criteria per local Building Code.

e. Acoustic Resistance

1) The OITC (Outdoor-Indoor Transmission Class) of fenestration products shall be a composite OTIC of 30 minimum, and per local Building Code.

10. Insulation Barrier: Design, fabricate and install exterior enclosure work with an integral continuous insulation barrier and vapor barrier to provide an insulated exterior enclosure system.

a. The R-value or thickness shown on the drawings is the minimum effective thermal value or thickness for the insulation barrier. Provide additional insulation thickness to compensate for losses in insulation value due to wall supports configuration, gaps and tolerances between wall panels and other wall assembly component requirements.

b. U-Factors of fenestration products (windows, glazed doors, curtain walls, storefronts and skylights) shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and labeled and certified by the manufacturer.

c. The solar heat gain coefficient (SHGC) of glazed fenestration products (windows, glazed doors, curtain walls, storefronts and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory and labeled and certified by the manufacturer.

d. Locate moisture sensitive materials in areas protected from exposure to moisture, including moisture from sources of temporary exposure prior to

installation of contiguous work.

e. Provide a complete and uninterrupted vapor barrier separate from or combined with the other wall barrier systems.

11. Owner's Building Maintenance (Window Washing) System: Design, fabricate and install the exterior enclosure systems so that the completed exterior enclosure will incorporate the clearances, dimensions, configurations and withstand the loads created by the Owner's selected building maintenance (window washing) system. Loads induced by the Owner's building maintenance (window washing) system shall be considered to act simultaneous with the design wind pressures. Design criteria for building maintenance (window washing) system including anchorage and equipment shall be furnished by Owner.

12. Louvers

a. General: Provide louvers bearing AMCA certified rating seal and meeting the following performance requirements:

1) Free Area: Not less than 50% **(TBD)** free air for a 48 in. x 48 in. size unless otherwise shown or specified.

2) Static Pressure Loss: Not more than 0.15 in. of water gage at an airflow of 1050 fpm **(TBD)** free area velocity in intake direction.

3) Beginning Point of Water Penetration: Not more than 0.01 oz./ft.^{2} of free area at an airflow of 1000 fpm **(TBD)** free air velocity when tested for 15 minutes.

b. Entire louver assembly utilized in the final Work shall provide the percentage of free air shown for the respective locations.

c. Design assembly so that objectionable noises are not created when installed assembly are subjected to wind loads within the range from 0.0 psf to the design load specified.

13. Lighting Fixtures: In areas of lighting fixtures at the exterior enclosures, provide a complete system of exterior enclosure work behind and circumventing the lighting fixtures meeting the "performance criteria" respectively for each specific contiguous wall system.

a. Design, fabricate and install the exterior enclosure systems so that the completed exterior enclosures will incorporate and withstand the loads created by the lighting fixtures work.

b. Provide exterior enclosure work at lighting fixture locations, coordinated with the requirements of those trades. Provide for re-lamping of lighting fixtures without the disassembly of exterior enclosure system. Provide mounting supports and other items required by the lighting fixtures.

14. Unacceptable Conditions: Vibration harmonics, wind whistles, noise or vibration created by thermal movement, structural movement, or wind; thermal movement transferred to building structure; loosening, weakening or failure of fasteners, attachments or other components.

15. Design Modifications: Make design modifications of work shown only as may be necessary to meet performance requirements and coordinate the work. Variations in details and materials which do not adversely affect appearance, durability or strength shall be submitted to the Architect for review. Maintain the general exterior design concept without altering profiles and alignments shown.

1.4 SUBMITTALS

A. List of Exterior Enclosure Suppliers: Before submission of shop drawings or samples, submit, for Architect's and Owner's information, a complete listing of products, manufacturers and fabricators for the principal exterior enclosure components. Architect's review of listed firms will be tentative, subject to review of subsequent submittals. Also, complete the submittal of manufacturer's data and samples required by other Sections of these specifications, prior to submittal of shop drawings.

B. Product Data: Submit for Architect's action Submit manufacturer's literature and specifications identifying locations and describing the general properties of each material and accessory to be used in the Work including primary function, quality, performance, location and details of construction relative to materials, dimensions of individual components, profiles, and finishes. Include a statement that each product to be furnished is recommended for the application shown. In addition, include complete instructions for handling, storing, mixing, priming, installing, curing and protecting each glazing material.

C. Shop Drawings: Submit, for Architect's action. Submit shop drawings for the fabrication and installation of the Exterior Enclosure Work. Prepare details at not less than 3 in. = 1 ft. minimum scale. Shop drawings shall be prepared by and contain the seal of a qualified licensed Professional Engineer registered in the State of Arkansas. Include the following:

1. Show typical and atypical details at large scale of conditions for every member, joint, anchorage and glazing system. Show details of support system, method of attachment to building structure, anchorage details and interface with adjacent work. Show component locations and intersection details. Provide information as to bolt torquing requirements. Show method of isolating dissimilar materials.

2. Show provisions for expansion and contraction.

3. Show method of accommodating wind induced and live load interstory differential vertical and horizontal movement.

4. Show provisions for seismic drift, typically and at corners.

5. Show method of drainage of the system including gutters, weeps and flashings

including method of drainage of condensation which might form external to the vapor barrier.

6. Show reglazing sequence both in the factory and remedial for the field.

7. Show percentage of free air of louvers.

8. Combined Submittals: Assemble shop drawings of the principal component parts, which may be specified in other Sections, into this submittal and prepare coordination details and erection diagrams for the entire exterior enclosure system. In addition, coordinate other work which is contiguous to the exterior enclosure system but not part of the system into this shop drawing submittal. Submit Shop Drawings for other items as denoted in related exterior enclosure specification Sections referenced in herein.

9. Show in this submittal that the exterior enclosure system has received the prior approval of the Contractor, the single firm awarded the exterior enclosure work, and the manufacturer or fabricator of each principal component, including metal, glass, plastic, sealant and gasketing components.

10. Indicate where and how the system deviates from the Contract Documents. Show section moduli of wind load bearing members and calculations of stresses and deflections. Provide material properties and other information needed for structural analysis.

D. Layout Drawings for Anchorage: Submit, for Architect's information, location drawings for fastenings and anchorages to be embedded in concrete showing type of fixing, location, setting-out dimensions and acceptable setting tolerances. Complete floor plans, elevations (if required) and full-size details of the embedded anchorage shall be submitted for review along with a fully coordinated set of structural calculations. Details of each type of embedded anchor and/or fixing shall be included within this submittal. Details shall be drawn full size and completely noted. Areas of the building for which exterior cladding shall be attached by means of embedded anchorage shall be identified and included. Areas of the building for which exterior cladding shall be attached without the use of embedded anchorage shall also be identified.

E. Closeout Submittals: Submit, for Owner's documentation,

1. Warranties: Special warranties specified.

2. Maintenance Manual: Two (2) copies of an assembled and bound maintenance manual, describing the materials, devices and procedures to be followed in cleaning and maintaining the exterior enclosure. Include manufacturer's brochures describing the actual materials used in the Work, including metal alloys, finishes, glass, sealants, gaskets and other major components.

1.5 QUALITY ASSURANCE

A. Basis of Design: When particular manufacturers' materials, products or processes are

specified for an item of Work, any one is acceptable for the Contractor to choose. An alternative material, product or process will be considered if the Contractor submits a written substitution request together with such information as may be necessary to assist the Architect in determining whether the proposed substitution is acceptable; the burden of proof rests solely upon the Contractor.

B. Fabricator/Installer Source Limitations: So that there will be undivided responsibility, award the exterior building enclosure work to a single firm specializing in this type work, with a minimum of 5 years continuous operations and experience which has successfully completed, comparable sized projects. This Work includes but is not limited, to designing, engineering, fabricating, transporting and erecting the exterior building enclosure system so that performance and aesthetic requirements are complied with.

C. Engineering Responsibility: Engage the services of a qualified Professional Engineer who is licensed to practice in the state where the project occurs and who is experienced in providing engineering services of the kind indicated to prepare or supervise the preparation of data for the exterior enclosure systems, including drawings, testing program development, test-result interpretation, and comprehensive engineering analysis that show the systems' compliance with the specified requirements. Engineering services are defined as those performed for installations of systems that are similar to those indicated for this Project in material, design, and extent.

D. Product Options: Information on Drawings and in Specifications establishes requirements for exterior enclosure system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sight lines and relationships to one another and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including established engineering methodology (i.e., calculations) preconstruction testing, field testing, and/or in-service performance.

E. Intended Aesthetic Effects: Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval and only to the extent needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

F. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from authorities

G. Pre-Installation Meeting: Prior to the start of the Work, meet at the Project site to review material selections, availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays, methods and sequence of exterior enclosure installation, structural load limitations, special details and conditions, standard of workmanship, quality control requirements, testing, inspecting, and certifying procedures, job organization, coordination with other trades, and other pertinent topics related to the Work.

1.6 WARRANTY

A. The Warranty submitted under this Section shall not deprive the Owner of other rights or remedies that the Owner may have under other provisions of the Contract Documents and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1. Special Warranty, Exterior enclosure: Submit for Owner's documentation. Provide a written warranty, for a **[ten (10)] [five (5)]** year period from defects of materials or workmanship. Repair or replace exterior enclosure work and correct leaks and/or other defects in material or workmanship during the warranty period. Warranty shall be signed by the Contractor and the single firm awarded the exterior enclosure work. Upon notification of defects, within the warranty period, make the necessary repairs or replacements, including cost of materials and labor, at the convenience of the Owner.

   a. Defects: Defects are defined to include, but not limited to the following:

      1) Failure of the system to meet performance requirements including but not limited to excessive deflection, racking, warpage, water leakage or air infiltration.

      2) Cracking, pitting or discoloration of glass reflective coatings or decorative coatings.

      3) Loss of effective glass bite due to shifting of glass or loss of effective glass bearing of setting blocks due to shifting of glass and/or blocks.

      4) Failure of operational parts to function normally.

      5) Deterioration, fading, excessive non-uniformity, pitting, cracking, peeling, crazing or discoloration of finishes and other materials beyond normal weathering.

      6) Adhesive or cohesive sealant failures or crazing on surface of sealant.

      7) Disengagement of gaskets or weatherstrips.

      8) Collapse of thermal insulation or safing insulation.

2. Special Warranties: Certain materials associated with the exterior enclosure are required to have special warranties, which shall not limit or reduce the requirements of the exterior enclosure system warranty. Special warranties may originate, in part or in whole, with manufacturers or fabricators and pass through the Contractor to the Owner. However, warranties as written or interpreted by manufacturers or fabricators shall not limit or reduce the special warranty requirements of this specification. Submit warranties for other items as denoted in related exterior enclosure specification sections.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Materials shall be new and free from defects that may impair the strength, functioning, durability or appearance of the Exterior Enclosure System or adjacent construction. Testing by an independent testing laboratory or review of data by the Architect shall not mitigate the Contractor's responsibility for performance of the Exterior Enclosure System nor relieve the Contractor of it’s responsibility to verify for himself that the work conforms to the Contract Documents.

2.2 FABRICATION

A. General: Fabricate exterior enclosure components to meet performance and aesthetic criteria specified. Fabricate exterior enclosure system at the manufacturer's shop to the fullest extent possible and before applying finishes. Fabricate system with materials proven compatible in testing specified.

B. Assembly: Carefully fit and assemble work with continuity of line and design, using rigidly secured joints with hairline contact, unless otherwise shown. Form butt hairline joints with roll-over edge exposed. Grind off roll-over edge flush with and matching of adjacent metal. Shop assemble work. Make all cutouts for penetrations at the factory and reinforce as required. Disassemble units too large for shipment and provide alignment and splice plates for accurate field fit.

C. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing. Exposed edges of metal shall be finished to match finish of face of work.

D. Reinforcing: Reinforce members and joints with structural shapes and plates in concealed locations, as necessary for adequate strength, sag resistance and rigidity and to comply with performance criteria. Separate metal surfaces at moving joints with plastic inserts or other non-abrasive concealed inserts which will permanently prevent "freeze-up" of the joint. Fabrication of supporting steel elements shall be in accordance with AISC Manual of Standard Practice.

E. Changes of plane, parallel or transverse to longitudinal axis shall be accomplished as indicated in the factory with a minimum of field fabrication.

F. Fasteners: Prepare components to receive concealed fasteners, anchors and connection devices.

G. Fabricate mullions in sections not less than 1 storey high. Insert compressible foam fillers into ends of every vertical mullion at each floor line to prevent convection currents within mullion tube.

H. Finishing: Ensure grain and extruding direction or rolling direction of aluminum is in

same direction for visual appearance. Where applicable apply paint finish in same direction as grain and extruding direction of metal.

I. Moisture Drainage: Fabricate components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior. Reinforce members and joints with steel plates, bars, rods or angles for rigidity and strength as needed to fulfill performance requirements. Use concealed Series 300 stainless steel fasteners for jointing which cannot be welded.

J. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld before finishing components. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

K. Dissimilar Metals: Separate dissimilar metals with dielectric separator to prevent galvanic action. Do not extend coatings onto exposed surfaces

L. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to GANA's "Sealant Manual" and "Glazing Manual".

M. Unitized Construction: Factory assemble unitized construction according to approved Shop Drawings to greatest extent possible. Rigidly secure nonmovement joints. Seal joints watertight, unless otherwise indicated. Assemble components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

N. Factory-Glazed Structural Silicone Glazing Work: Clean frames and glass surfaces with an approved solvent. Prime surfaces and apply structural sealant in accordance with manufacturer's recommendations and ASTM C1401 "Standard Guide for Structural Sealant Glazing". Clean excess structural sealant before curing. Do not transport units until silicone has cured.

2.3 EXTERIOR WALL SYSTEMS (EWS)

A. **EWS-501**

1. Standing Seam Metal Panel Wall System, as indicated on drawings.

2. Metal Panel [**MTL-08**]:

   a. Basis of Design: M.G. McGrath
   b. Type: Standing Seam
   c. Metal: Weathering Steel
   d. Width: 16 inches
   e. Thickness: 22ga

3. Insulation - Mineral Wool [**INS-01**]

a. Thickness: 4 inch
b. Type: Semi-Rigid
c. Basis of Design: “CavityRock” (Rockwool)

4. Air Water Barrier [**ABS-01**]

a. Basis of Design: Fluid-Applied (Henry)

5. Sheathing

a. Basis of Design: “Securerock” (USG)
b. Thickness: 5/8 inch.

6. Metal Panel Wall system shall include all cold-formed metal wall framing [**CFMF-01**], miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, sealants and joint filler; including bent steel plate and steel angle framing, anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

B. **EWS-502**

1. Standing Seam Metal Panel Wall System, as indicated on drawings.

2. Metal Panel [**MTL-08**]:

a. Basis of Design: M.G. McGrath
b. Type: Standing Seam
c. Metal: Weathering Steel
d. Width: 16 inches
e. Thickness: 22ga

3. Insulation - Mineral Wool [**INS-01**]

a. Thickness: 4 inch
b. Type: Semi-Rigid
c. Basis of Design: “CavityRock” (Rockwool)

4. Air Water Barrier [**ABS-01**]

a. Basis of Design: Fluid-Applied (Henry)

5. Sheathing

a. Basis of Design: “Securerock” (USG)
b. Thickness: 5/8 inch.

6. Metal Panel Wall system shall include CMU [**CMU-01**] Back-up Wall, all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, sealants and joint filler; including bent steel plate and steel angle

framing, anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

C. **EWS-503**

1. Weathering Steel Metal Panel Wall System with Expanded Metal Screen, as indicated on drawings.

2. Weathering Steel Panel [**MTL-12**]

   a. Basis of Design: M.G. McGrath
   b. Type: Flat Lock, S-Slip
   c. Metal Panel: Weathering Steel
   d. Thickness: 16ga

3. Expanded Metal Panel [**MTL-11**]

   a. Basis of Design: Amico Architectural Metals
   b. Type: APEX-03
   c. Metal Panel: Weathering Steel
   d. Thickness: **TBD**

4. Insulation - Mineral Wool [**INS-01**]

   a. Thickness: 4 inch
   b. Type: Semi-Rigid
   c. Basis of Design: “CavityRock” (Rockwool)

5. Air Water Barrier [**ABS-01**]

   a. Basis of Design: Fluid-Applied (Henry)

6. Sheathing

   a. Basis of Design: “Securerock” (USG)
   b. Thickness: 5/8 inch.

7. Metal Panel Wall system shall include all wall framing, miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, sealants and joint filler; including bent steel plate and steel angle framing, anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

D. **EWS-504**

1. Flush Metal Panel Wall System, as indicated on drawings.

2. Metal Panel [**MTL-10**]

a. Basis of Design: M.G. McGrath
b. Type: Flush Seam, F-Seam
c. Metal Panel: Weathering Steel
d. Thickness: 16ga

3. Insulation - Mineral Wool [**INS-01**]

a. Thickness: 4 inch
b. Type: Semi-Rigid
c. Basis of Design: “CavityRock” (Rockwool)

4. Air Water Barrier [**ABS-01**]

a. Basis of Design: Fluid-Applied (Henry)

5. Sheathing

a. Basis of Design: “Securerock” (USG)
b. Thickness: 5/8 inch.

6. Metal Panel Wall system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, sealants and joint filler; including bent steel plate and steel angle framing, anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

E. **EWS-505**

1. Weathering Steel Metal Panel Wall System with Perforated Metal Screen, as indicated on drawings.

2. Weathering Steel Panel [**MTL-12**]

a. Basis of Design: M.G. McGrath
b. Type: Flat Lock, S-Slip
c. Metal Panel: Weathering Steel
d. Thickness: 16ga

3. Perforated Standing Seam Metal Screen [**MTL-09**]

a. Basis of Design: M.G. McGrath
b. Type: Perforated Standing Seam Metal with 50% plus free-air
c. Metal: Weathering Steel
d. Width: 16 inches
e. Thickness: 22ga

4. Insulation - Mineral Wool [**INS-01**]

a. Thickness: 4 inch

b. Type: Semi-Rigid
c. Basis of Design: “CavityRock” (Rockwool)

5. Air Water Barrier [**ABS-01**]

a. Basis of Design: Fluid-Applied (Henry)

6. Sheathing

a. Basis of Design: “Securerock” (USG)
b. Thickness: 5/8 inch.

7. Metal Panel Wall system shall include all cold-formed metal wall framing [**CFMF-01**], miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, sealants and joint filler; including bent steel plate and steel angle framing, anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

F. **EWS-801 STICK-BUILT GLAZING ASSEMBLY**

1. Unitized, aluminum framed, structurally glazed (with pressure caps where indicated), insulated and spandrel glass curtain wall system with concealed reinforcing as required. Provide details and dimensions allowing for field adjustments and thermal movement. Operable windows where indicated on drawings.

2. Basis of Design: 2 Sided Capture System by YKK Architectural Products

a. Or equal by Kawneer

3. Mullions [**MTL-02]:**

a. Metal/Finish: **PT-03** Painted Aluminum Finish
b. Manufacturer: Sherwin Williams
c. Color: “Steel Horizon”
d. Type: Fluropon Classic II

4. Glazing [**GL-01**]:

a. IGU
b. Clear
c. Low-E Coated

G. **WND-01 PUNCHED OPENING WINDOW SYSTEM**

1. Thermally broken window system with operable capabilities. Accommodate insulated glazing units.

2. Basis of Design: YKK Architectural Products

a. Or equal by Kawneer

3. Frames [**MTL-02**]:

a. Metal/Finish: **PT-03** Painted Aluminum Finish
b. Manufacturer: Sherwin Williams
c. Color: “Steel Horizon”
d. Type: Fluropon Classic II

4. Glazing **[GL-01**]:

a. IGU
b. Clear
c. Low-E Coated

2.4 EXTERIOR ROOF SYSTEMS (ERS)

A. **ERS-501**

1. Standing Seam Metal Panel Roof System, as indicated on drawings.

2. Roof Panel [**MTL-08**]

a. Basis of Design: M.G. McGrath
b. Type: Standing Seam
c. Metal: Weathering Steel
d. Width: 16 inches
e. Thickness: 22ga

3. Waterproofing and Flashing [**RS-01**]

a. Basis of Design: Vycor Ultra (Grace)

4. Sheathing

5. Insulation [**INS-02**]

a. Type: Polyisocyanurate
b. Thickness: As indicated on drawings
c. Basis of Design: "ENRGY 3 Plus " (Johns Manville).

6. Air Vapor Retarder [**VRS-01**]

a. Self-adhesive SBS modified bitumen membrane, 31 mil thick, with a tri-laminated woven polyethylene facer.

7. Substrate, as indicated on drawings

a. Pre-Cast Concrete Deck

8. Metal Panel Roof system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, flashing, closures, sealants and joint filler; including anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

B. **ERS-502**

1. Standing Seam Metal Panel Roof System, as indicated on drawings.

2. Standing Seam Roof Panel [**MTL-08**]

a. Basis of Design: M.G. McGrath
b. Type: Standing Seam
c. Metal: Weathering Steel
d. Width: 16 inches
e. Thickness: 22ga

3. Waterproofing and Flashing [**RS-01**]

a. Basis of Design: Vycor Ultra (Grace)

4. Sheathing

5. Insulation [**INS-02**]

a. Type: Polyisocyanurate
b. Thickness: As indicated on drawings
c. Basis of Design: "ENRGY 3 Plus " (Johns Manville).

6. Air Vapor Retarder [**VRS-01**]

a. Self-adhesive SBS modified bitumen membrane, 31 mil thick, with a tri-laminated woven polyethylene facer.

7. Sheathing (if required)

a. Basis of Design: “Securerock” (USG)
b. Thickness: 5/8 inch.

8. Substrate, as indicated on drawings

a. Structural Metal Deck

1) Type: Acoustical

9. Metal Panel Roof system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, flashing, closures, sealants

and joint filler; including anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

C. **ERS-503**

1. Standing Seam Metal Panel Roof System, as indicated on drawings.

2. Standing Seam Roof Panel [**MTL-08**]

   a. Basis of Design: M.G. McGrath
   b. Type: Standing Seam
   c. Metal: Weathering Steel
   d. Width: 16 inches
   e. Thickness: 22ga

3. Waterproofing and Flashing [**RS-01**]

   a. Basis of Design: Vycor Ultra (Grace)

4. Sheathing

5. Insulation [**INS-02**]

   a. Type: Polyisocyanurate
   b. Thickness: As indicated on drawings
   c. Basis of Design: "ENRGY 3 Plus " (Johns Manville).

6. Air Vapor Retarder [**VRS-01**]

   a. Self-adhesive SBS modified bitumen membrane, 31 mil thick, with a tri-laminated woven polyethylene facer.

7. Sheathing

   a. Basis of Design: “Securerock” (USG)
   b. Thickness: 5/8 inch.

8. Substrate, as indicated on drawings

   a. Structural Metal Deck

      1) Type: Solid

9. Metal Panel Roof system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, flashing, closures, sealants and joint filler; including anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

D. **ERS-504**

1. Perforated Standing Seam Metal Panel Screen with Built-Up Roof System, as indicated on drawings.

2. Perforated Standing Seam Metal Screen [**MTL-09**]

   a. Basis of Design: M.G. McGrath
   b. Type: Perforated Metal with 50% plus free-air
   c. Metal: Weathering Steel
   d. Width: 16 inches
   e. Thickness: 22ga

3. Built-Up Roofing System [**RS-03**]

   a. Basis of Design: Henry
   b. Type: Provide walkable surface for Maintenance Access.

4. Sheathing

5. Insulation [**INS-02**]

   a. Type: Polyisocyanurate
   b. Thickness: As indicated on drawings
   c. Basis of Design: "ENRGY 3 Plus " (Johns Manville).

6. Air Vapor Retarder [**VRS-01**]

   a. Self-adhesive SBS modified bitumen membrane, 31 mil thick, with a tri-laminated woven polyethylene facer.

7. Substrate, as indicated on drawings

8. Metal Panel Roof Screen system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, flashing, closures, sealants and joint filler; including anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

2.5 EXTERIOR SOFFIT SYSTEMS

A. **ESS-601 METAL PANEL SOFFIT SYSTEM**

1. Flush Seam Metal Panel System, as indicated on drawings.

2. Metal Panel [**MTL-10**]

   a. Basis of Design: M.G. McGrath
   b. Type: Flush Seam

c. Metal Panel: Painted Steel
d. Thickness: 16ga

3. Insulation - Mineral Wool [**INS-01**]

a. Thickness: 4 inch
b. Type: Semi-Rigid
c. Basis of Design: “CavityRock” (Rockwool)

4. Air Water Barrier [**ABS-01**]

a. Basis of Design: Fluid-Applied (Henry)

5. Substrate, as indicated on drawings

6. Metal Panel Soffit system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, flashing, closures, sealants and joint filler; including anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

B. **ESS-602 METAL PANEL SOFFIT SYSTEM**

1. Expanded Metal Panel System, as indicated on drawings.

2. Expanded Metal Panel [**MTL-11**]

a. Basis of Design: M.G. McGrath
b. Type: Expanded Metal Mesh
c. Metal Panel: Pre-Weathered Weathering Steel
d. Thickness: TBD

3. Insulation - Mineral Wool [**INS-01**]

a. Thickness: 4 inch
b. Type: Semi-Rigid
c. Basis of Design: “CavityRock” (Rockwool)

4. Air Water Barrier [**ABS-01**]

a. Basis of Design: Fluid-Applied (Henry)

5. Substrate, as indicated on drawings

6. Metal Panel Soffit system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, flashing, closures, sealants and joint filler; including anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

2.6 EXTERIOR FASCIA SYSTEMS

A. **EFS-501**

1. Flush Metal Panel System, as indicated on drawings.

2. Metal Panel [**MTL-10**]

   a. Basis of Design: M.G. McGrath
   b. Type: Flush Seam
   c. Metal Panel: Weathering Steel
   d. Thickness: 16ga

3. Insulation - Mineral Wool [**INS-01**]

   a. Thickness: 4 inch
   b. Type: Semi-Rigid
   c. Basis of Design: “CavityRock” (Rockwool)

4. Air Water Barrier [**ABS-01**]

   a. Basis of Design: Fluid-Applied (Henry)

5. Sheathing

6. Basis of Design: “Securerock” (USG)

   a. Thickness: 5/8 inch.

7. Metal Panel Wall system shall include all miscellaneous framing, sub-framing, attachment clips and fasteners, sheet metal accessories, sealants and joint filler; including bent steel plate and steel angle framing, anchors, and attachments for the system to structure, as shown on drawings and as required for complete installation.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturer's Instructions: Prepare substrates, and erect the work of this Section, including components, and accessories in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified, and where project conditions require extra precautions or provisions to ensure satisfactory performance of the Work.

3.2 EXAMINATION

A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Ensure openings and recesses to receive

work of this Section are within acceptable tolerances. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Substrate Acceptability: Commencement of installation shall constitute acceptance of substrate conditions by the Installer.

B. Anchor Assemblies: Furnish at times appropriate to the construction schedule, for installation by others, anchor assemblies, inserts and other anchorage components associated with and intended to support the exterior enclosure which are to be set into concrete, masonry or secured to structural steel framing.

1. After concrete is cast, the exact position of the embedded anchors shall be verified by the Contractor and the exterior enclosure erector and discrepancy or misalignment shall be reported to the Architect immediately upon discovery for adjustment to be made. Subsequent submissions on remedial anchors shall be made at that time.

2. Unless otherwise indicated, work to be built into concrete or masonry shall be anchored with shop welded galvanized steel strap anchors. Work attached to structural steel shall be anchored by pre-welded members or bolts.

3. Make necessary modifications to the anchor ties to suit different site conditions of steel reinforcements without additional charge.

4. Provide additional anchorage assemblies insert in location adjacent to permanent anchors for pull out testing purposes. Install utilizing same system as permanent anchors. Show locations and numbers of test anchors on shop drawings for approval. Comply with “In-Situ Embeds and Anchor Testing” requirements specified in paragraph “Field Quality Control”.

C. Dimension Verification: Verify dimensions of supporting structure by field measurements so that exterior enclosure work will be accurately designed, fabricated and fitted to the structure. Tolerances for supporting structure are specified in other Sections.

D. Coordination: Coordinate exterior enclosure work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Place items, including inserts and anchors, accurately in relation to the final location of exterior enclosure components. Postpone work in areas required to be open for materials handling.

3.4 ERECTION

A. Assembly: Components shall be assembled, secured, anchored, reinforced, sealed and made weather tight in a manner not restricting thermal and wind movements of the system as well as building movements. Free and silent movement of components of the exterior cladding system due to these loads and movements shall be achieved without

strain to glass, buckling of component or excessive stress to members or assemblies.

B. Erection: Erect components of the exterior enclosure in accordance with the manufacturer's written instructions and recommendations. Anchor components securely in place in the manner shown on the final shop drawings. Shim and allow for movement resulting from changes in thermal conditions and building movements. Provide separators and isolators to prevent corrosion, electrolytic deterioration, and freeze-up of moving joints.

1. At dynamic connections, where required, and unless otherwise shown, provide type 316 stainless steel for shims, blocking and spacers incorporating separators for dissimilar materials. Do not use horseshoe (U) shaped shims at dynamic connections.

2. Do not use plastic shims at structural connections. Stacking of shims shall not be permitted where conditions of structural failure may occur. Utilize solid shims where required.

C. Assumed Design Temperature: Dimensions shown on Drawings are based on an assumed design temperature of 70 deg. F.. Fabrication and erection procedures shall take into account the ambient temperature at the time of the respective operations.

D. Fastening

1. Attachment of the wall to the structure shall be by approved methods in strict accordance with accepted shop and/or erection drawings. Supporting brackets shall be so designed as to provide three-dimensional adjustment and accurate location. Once the wall is properly positioned, connections so designated on accepted shop drawings shall be rigidly fixed by welding or other positive mechanical means.

2. Expansion anchorage shall be so designed to accommodate thermal and building movements. Anchorage design shall provide for unrestricted movement. Molybdenum-disulfide filled nylon (“Nylatron”) slip pads or washers shall be used at thermal or dynamic anchors.

3. Anchor component parts securely in place by bolting, welding or other permanent mechanical attachment system, which will comply with performance requirements and permit movements which are intended or necessary. Install slip pads between moving parts.

4. Steel fasteners shall comply with requirements described herein. Welding shall be done by skilled mechanics qualified or licensed in accordance with local building regulations and shall conform to the recommended practices of the American Welding Society. Special care shall be taken to protect glass and other finished surfaces from damage and to prevent fires.

5. Weld spatter on glass or exposed surfaces will be cause for rejection of glass or other exposed material. Glass with weld spatter will be replaced at no cost to the

Owner.

6. Touch up welds or damage to structural steel coating with two (2) coats of an epoxy paint or zinc rich primer compatible with existing primer and as approved by the Architect.

7. Provide supplementary parts necessary to complete each item of work of attachments. Attachment devices shall be of type, size and spacing to suit condition and as approved by the Architect. Provide shims, slotted holes or other means necessary for leveling, plumbing and other required adjustments. Attachment devices for work exposed to view shall be concealed unless otherwise indicated. Where bolts or screws are permitted in work exposed to view, they shall match adjacent surfaces.

8. Do necessary drilling, tapping, cutting, shimming, welding or other preparations of surrounding construction on site accurately, neatly and as necessary for the attachment and support of work of this section.

9. Where design requires moving metal parts, parts shall be separated and coated or treated to ensure proper movement, without noise, binding or metal to metal contact. Isolate materials where necessary with 1/8 in. (minimum thickness) high impact polystyrene isolator pads to prevent electrolysis between dissimilar metals.

E. Field Installation of Preglazed Panels

1. Inspect each preglazed unit immediately before installation and eliminate pieces which have observable edge damage or face imperfections. Check frames to receive units for squareness and trueness. Verify that perimeter clearances are sufficient to prevent "point loading" and that surfaces are clean, dry, and ready to receive preglazed units. Verify that frame corners are weather tight and that sills are drained to exterior. Remove protective coatings from framing surfaces.

2. Watertight and airtight installation of each preglazed unit is required. Each installation shall withstand failure including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials and other defects in the work.

3. Protect glass from edge damage at times during handling, installation and operation of the building. Glass breakage during the guarantee period will be considered a form of faulty material or workmanship unless known to result from vandalism or other causes not related to materials and workmanship.

4. Preglazed units shall be stored in a dry, well-ventilated location. Handling of glass shall be kept to a minimum, and glass shall be carefully protected from soiling and from condensation.

5. Gaskets shall be vulcanized (injection molded) at corners where compatible with installation procedure. Where gasket joints occur, tightly butt end and seal with a compatible sealant.

6. Where applicable, comply with GANA Glazing Manual Guidelines. Provide a minimum nominal glass bite of 1/2 in.. Where joint movement will result in variable glass bite, increase nominal bite as required and provide 1/4 in. minimum edge clearance, or greater clearance where lateral building movement is taken by the glazing seals

7. Thoroughly clean glazing pocket before setting glass. Solvents shall be compatible with finished aluminum, glass and glazing materials. Place setting blocks at quarter points. Place side blocks in the upper half of each jamb, where required. Side blocks, setting blocks and chairs shall be positively retained in position.

8. Remove and replace stops and apply sealants as required for a complete glass installation. Details of installation shall permit replacement of glass after the construction period.

9. Defer glazing of openings which are obstructed during construction. Glaze openings when obstructions are removed.

10. Install wet seals, heel beads, toe beads, interior wet seals and structural silicone seals as indicated by architectural details.

11. Use pre-formed custom shape extruded silicone gasket at the butt glazed vision glass. Gasket is intended to prevent silicone contact with the PVB laminate. Gasket shall adhere to wet silicone.

12. Each and every piece of glass shall be subject to approval, and may be rejected after having been set or erected. Rejected glass shall be carefully removed and replaced with new suitable glass without delay and without cost to the Owner. Piece or pieces damaged in the removal and resetting of defective or rejected pieces shall also be removed, with new and acceptable pieces provided and installed at no cost to the Owner.

13. Remove and replace exterior glass lights which are broken, chipped, stained or otherwise damaged including coating defects or which, in the opinion of the Architect, do not conform to the Specification requirements. Where directed, remove and replace lights which do not match adjoining work. Provide new matching lights, install as specified and seal joints to eliminate evidence of replacement.

F. Structural Silicone Glazed Units

1. Comply with manufacturer's instructions for protecting, handling, and installing fabricated structural sealant glazed exterior enclosure components, with particular care and attention to preservation of edges and sealants. Discard or remove and replace damaged members.

2. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.

Preparation includes, but is not limited to, cleaning and priming surfaces. Install structural sealant glazed exterior enclosure in accordance with approved shop drawings, using workers specifically trained in the installation of structural sealant glazed walls. Mechanically fasten glazing in place until structural sealant is cured.

3. Anchor components securely in place in the manner indicated. Shim and allow for movement resulting from changes in thermal conditions. Provide separators and isolators to prevent corrosion, electrolytic deterioration, and "freeze-up" of moving joints.

4. Structural silicone glazing work shall be assembled in the controlled environment of the fabricator's shop. No structural silicone glazing will fabricated in the field except as approved by the Architect.

5. Install secondary weatherseal sealant according to sealant manufacturer's written instructions to provide weatherproof joints between glazed units. Prime substrates and install joint fillers behind sealant as recommended by weatherseal sealant manufacturer.

6. Field-Glazed Structural Silicone Glazing Remedial Work: In accordance with fabricator’s submitted re-glazing procedure, clean frames and glass surfaces with an approved solvent. Prime surfaces and apply structural sealant in accordance with manufacturer's written recommendations. Clean excess structural sealant before curing. Mechanically hold glass firmly in place until sealant is sufficiently cured. Install compressible backer rods in joint before applying weatherseal sealant.

G. Coordinate and provide items, in a timely manner so as to allow for the installation and protection of specified roofing systems specified elsewhere.

H. Building Maintenance Components: Erect and anchor building maintenance components level, plumb and true to line and in accordance with Owners design criteria. Erect components in accordance with shop drawings and erection schedules.

I. Erection Tolerances: Erect component parts within the following tolerances:

1. Variations from plumb or angle shown: 1/8 in. maximum variation in story height or 10 ft run, noncumulative.

2. Variations from level or slopes shown: 1/8 in. maximum variation in column-to-column space or 20 ft. run, noncumulative.

3. Variations from theoretical calculated position as located in plan or elevation in relation to established floor lines, column lines and other fixed elements of the structure, including variations from plumb and level: 1/4 in. maximum variation in column-to-column space, floor-to-floor height or 20 ft. run.

4. Offsets in end-to-end or edge-to-edge alignment of consecutive members: 1/16 in.

maximum offset in alignment.

5. Variations from Position at the Hypotenuse: Variation from theoretical calculated position at the hypotenuse of rectangular bay between mullions in story height.

   a. 1/4 in. maximum variation in 10 ft. length of hypotenuse, noncumulative.

   b. 3/8 in. maximum total variation in hypotenuse

J. Cutting and Trimming of Components: Cut and trim components of the exterior enclosure during erection only with the approval of the manufacturer or fabricator and in accordance with its recommendations. Do not cut through reinforcing or prestressing members. Restore finish completely to protect material and remove evidence of cutting and trimming. Remove and replace members where cutting and trimming has impaired strength or appearance.

K. Damaged Components: Do not erect members or other components which are warped, bowed, deformed or otherwise damaged to extent as to impair strength or appearance. Remove and replace members damaged in the process of erection.

L. Setting of Units: Set units level, plumb, and true to line, with uniform joints. Support on metal shims and secure in place by bolting to clip angles and similar supports anchored to supporting structure.

M. Dielectric Separation: Paint concealed contact surfaces of dissimilar materials with a heavy coating of dielectric separator (bituminous paint) or provide other separation in accordance with manufacturer's recommendations.

N. Welding: Weld with electrodes and by methods recommended by manufacturer of material being welded, and in accordance with appropriate recommendations of the AWS. Use only methods which will avoid distortion or discoloration of exposed faces. Grind exposed welds smooth, using only clean wheels and compounds which are free of iron or iron compounds. Restore finish of components after welding and grinding.

O. Soldering and Brazing: Solder and braze only to fill or seal joints (not to form structural joints) and in accordance with component manufacturer's recommendations. Grind smooth and restore finish.

P. Painting of Ferrous Metal Items: Paint clip angles and other ferrous metal parts with primer specified in Section 08 4050 “Glazed Curtain Walls”.

Q. Trim: For exterior enclosure utilizing exposed exterior mullion covers of the snap-on type design, provide a minimum of two (2) concealed fasteners per 5 ft. length to prevent displacement or accidental removal of trim. Show location of fasteners on shop drawings.

R. Firestopping/Safing and Smoke Seals: Clean debris from behind exterior enclosure during erection and provide temporary closures to prevent accumulation of debris. Install firestopping/safing to comply with local authorities having jurisdictions. Install firestopping/safing with securely anchored metal flanges or make equivalent provisions

to prevent dislocation. Install smoke seal over safing insulation so as to provide a complete smoke seal. Comply with Section 07 8400 “Firestopping”, appropriate UL listing and local authorities having jurisdiction.

S. Joint Sealant: Seal joints in exterior enclosure in accordance with Section 07 9200 “Joint Sealants”, in a concealed manner, unless exposed sealant is shown.

3.5 FIELD QUALITY CONTROL

A. Contractor’s Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

B. Contractor’s Testing and Inspection Program: The Contractor shall provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of items of Work, including those of other trades, to ensure compliance with the Contract Documents and the requirements of the local authorities having jurisdiction. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the construction operations within the actual construction sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Owner and governing authorities having jurisdiction.

C. Contractor Off-Site Testing

1. Exterior enclosure Mock-Ups Testing: The Contractor shall perform mock-up construction and testing, for each specific exterior enclosure system utilized on the Project, in accordance with the requirements specified in Section 08 03 55 "Exterior enclosure Mock-Ups and Testing".

D. Contractor’s Site Testing: The Contractor shall perform the following site testing of the exterior enclosure at times appropriate to the construction schedule and in compliance with direction of the Architect and the Owner's independent testing agency:

1. Structural Silicone Sealant Adhesion Test: Test installed structural silicone sealant according to field adhesion test method described in AAMA CW 13, "Structural Sealant Glazing Systems (A Design Guide)." Test a minimum of 2 areas on each building face.

2. Field Water Penetration Testing: After completion of the exterior enclosure installation and nominal curing of sealant and glazing compounds, and when and where directed, test for water leakage. : Conduct tests in the presence of the Architect, The Contractor, the Owner's Testing Agency, the exterior enclosure fabricator/erector and other subcontractors involved in the Work. Correct deficiencies observed as a result of this testing.

3. Water Hose Field Penetration Test: After completion of the installation and nominal curing of sealants and glazing compounds, and before installation of interior trim members, finishes and heating unit covers, test for water leaks by

performance of AAMA 501.2 "Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Wall and Sloped Glazing Systems" (with the exception of the definition of uncontrolled water). Provide powered scaffold, hose, radios, water supply and manpower to perform at least four (4) successful tests, plus repeat testing of unsuccessful tests. Test wall at 10%, 25%, 50%, and 100% completion.

a. Schedule work necessary, as out of sequence sealant work, so that the wall can be tested as specified. There shall be no unacceptable water leakage as defined herein. Depending upon the prevalence or absence of leakage in the initial water penetration test and upon measures adopted by the Contractor to eliminate source of leakage, Architect will determine necessity for, and scope of, additional tests and test methods. In no case will the total of tested area amount to less than 1% or less than 3 per elevation nor more than 10% except in cases of chronic leakage or as authorized by the Owner. Conduct tests in the presence of the Architect. Correct deficiencies observed as a result of this test.

4. Pressure Chamber Field Tests: Furnish portable test apparatus in accordance with AAMA 503, consisting of a pressurized enclosure sealed against the exterior enclosure on the indoor side, and a spray rack of pipe grid with nozzles to spray water onto the exterior of the wall. Provide test apparatus equivalent in size to mock-up, unless directed otherwise.

a. Air Infiltration: Test for resistance to air infiltration using static air pressure difference in accordance with AAMA 503 and ASTM E783 “Field Measurement of Air Leakage Through Installed Exterior Windows and Doors”. Test at 6.24 psf test pressure.

b. Water Penetration Test Method: Test for water penetration in accordance with AAMA 503 and ASTM E1105 requirements. Test at pressure at 20% of design pressure or 12 psf, whichever is greater.

c. Test Locations: Test areas shall be within the first 3 levels of a typical exterior enclosure construction at locations indicated by Architect, during installation of exterior enclosure and when the Work is approximately 10%, 50% and 90% complete. Perform tests after completion of the installation and nominal curing of sealants, and before installation of interior trim members and heating unit covers. Conduct tests in the presence of the Architect, who will determine the actual percentage of wall area to be tested based upon indication of leakage or lack thereof. Conduct one successful test for each location.

5. Post-Test Procedures: Repair or replace components, including joints and sealants, which leak or are observed to be defective, and retest as directed. Furnish a full written report of the testing procedures, results, and revisions or corrective procedures that shall be followed as a result of the testing.

3.6 OWNER’S MONITORING ACTIVITIES

A. Owner’s Testing Agency: An independent testing agency, engaged at the Owner’s expense, will perform the following activities to monitor the Contractor’s Quality Control Program including but not limited to inspection and testing of exterior enclosure work at the project site and, if work is performed off site, inspection and testing of exterior enclosure work in fabrication plants. The monitoring activities do not relieve the Contractor of responsibilities under the Contract.

B. Contractor's Assistance to the Owner's Testing Agency: Furnish the Owner's Testing Agency with access to the Work, materials and facilities as required by the Agency. Provide adequate notice of construction activities to allow timely inspections and observation of Contractor tests, and be available for pre-installation meetings. Furnish the Owner's Testing Agency with on-site office facilities

C. The Owners Testing Agency shall perform full-time inspection and testing of the exterior enclosure work during construction at timely occurrences to satisfy governing authority having jurisdiction and the quality control established for the Project by the Contract Documents.

1. Observation Compliance of Exterior enclosure Subcontractor's Testing Program

a. Laboratory Testing Mock-Ups: Observation, as the Owner's representative, of laboratory mock-up construction and mock-up testing of exterior enclosure assembly, for the required testing as specified in Section 08 0355 "Exterior enclosure Mock-Up and Testing".

2. Site Testing: Observation, as the Owner's representative, of the following site testing:

a. Water Hose Field Penetration Tests: Water hose field penetration testing of exterior enclosure assembly, for the required Water Hose Penetration Test: AAMA 501.2 as specified herein.

b. Pressure Chamber Field Tests: Site testing of exterior enclosure assembly, for the required Site Water Penetration Chamber Test: AAMA 503 under pressure differential as specified herein.

c. Embedded Anchor Testing Site Tests: Site testing of embedded anchor testing.

d. Structural Silicone Testing: Site testing for structural silicone sealant adhesion tests.

3.7 CLEANING

A. In addition to specific protection and cleaning methods required for each component by the respective Sections of these Specifications maintain the exterior enclosure throughout the construction period in a clean and properly protected condition so that it will not be damaged at the time of acceptance by the Owner.

B. Cleaning and protective methods shall be carefully selected, applied and maintained so that finishes will not become uneven or otherwise impaired as a result of unequal exposure to light and weathering conditions.

C. Final Cleaning: Clean the completed system, inside and out, promptly after erection and installation of glass and sealants, allowing for nominal curing of liquid sealants. Final cleaning shall be completed to the total satisfaction of the Owner.

3.8 PROTECTION

A. Contractor responsible for protection of exterior enclosure system from damage after erection until Substantial Completion. Remove and replace damaged or broken glass before Substantial Completion at no expense to Owner.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. General: Provide exterior enclosure mock-ups and testing work in accordance with requirements of the Contract Documents.

1.2 REFERENCES

A. General: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict between referenced standards, this specification or within themselves, the more stringent standard or requirement shall govern.

1. AAMA "Metal Curtain Wall Manual".

a. AAMA 501 “Methods of Test for Exterior Walls”.

b. AAMA 501.4 “Recommended Static Test Method Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Drifts”.

c. AAMA 501.5 “Test Method for Thermal Cycling of Exterior Walls”.

d. AAMA 501.6 “Recommended Dynamic Test Method for Determining the Seismic Drift Causing Fallout from a Wall System.”

e. AAMA 501.7 “Standard Practice for Determining the Thermal Performance Characteristics of Fenestration Systems Installed in Commercial

f. AAMA 1503.1 “Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections”.

1.3 DEFINITIONS

A. Water Leakage: Water leakage shall be defined as water that appears on normally exposed interior surfaces of the mock-up assembly and is not contained or drained back to the exterior.

B. Condensation: Condensation is defined as water, ice or frost on more than 5% of the interior surface of module or component of the wall or the accumulation or uncontrolled flow of water from condensation or melted frost on the wall at any location, or

condensation visible in the final construction.

C. Controlled Water: Water that is contained and drained back to the exterior.

1.4 SYSTEM DESCRIPTION

A. Mock-Ups: Build a mock-up(s) as shown, but not less than the requirements of AAMA Standard 501 and ASTM E331, Section 8, to be used as test specimen(s) and Owner's and Architect's visual examination. Architect's review shall be utilized as benchmark for project quality. Provide larger mock-up(s) if the proposed exterior enclosure details create a condition requiring larger mock-up(s) for proper evaluation and testing. Use the same materials, finishes, details, methods and structural anchorage system proposed for the exterior enclosure.

1. All parts of the test mockup(s) shall be full size, using the same materials, material finishes, details and methods of construction and anchorage as used or planned to be used in the building.

2. Accurately simulate conditions of structural supports back to a reasonably unyielding support and capable of completing testing regimen without failure. The test chamber or the specimen mounting frame or both, must not deflect under any scheduled test load in such a manner that the performance of the specimen will be affected. Failure of chamber specimen structural supports or anchorages at any time during testing, will require a redesign of the chamber support structure and complete re-testing both for preliminary and final testing.

B. Provide personnel to construct exterior enclosure mock-up(s) who will be the same personnel who will be performing and supervising the actual Work. In addition, construct mock-up(s) in the presence of the Independent Inspection agency retained by the Owner. Simulate actual construction conditions as accurately as possible in every way.

C. Provide extra materials as may be required to replace materials which fail during tests, except intentional failure tests beyond specified performance requirements. Glass used in the mock-up(s) shall be cut to the minimum tolerances expected in the final installation. Allow sufficient time for chemically curing sealants to achieve their proper cure as recommended by manufacturer.

D. Where mock-up specimens are constructed with corner sections (either inward or outward), both elevations shall be tested simultaneously wherever possible, with all surfaces exposed to air, water and structural test requirements.

1.5 SUBMITTALS

A. Material and Sample Submittals: Prior to construction of mock-up assembly, submit, for Architect's action, product data and representative samples for material to be used in mock-up(s) as required in other specification sections and complete with compatibility testing.

B. Proposed Test Procedures: Submit, for Architect's action, for each mock-up specified,

prior to the construction of the mock-up(s) and concurrent with the submission of mock-up shop drawings, calculations, material submittals and testing laboratory qualifications, a detailed description of each test procedure required for each mock-up coordinated with specified performance criteria and stating desired results. In addition, note proposed location, number and type of instrumentation to measure deflections, rotations and sets.

C. Calculations: Submit, for Architect's information, calculations together with shop and erection drawings to substantiate mock up(s) Work complies with specified design criteria. Calculations shall contain the seal of a licensed Professional Engineer registered in the State of Arkansas. Provide the following:

1. Submit engineering calculations to show that maximum deflections do not exceed specified performance requirements under full design loading.

2. Submit structural calculations for frames, connections, panels and anchorage assemblies.

D. Quality Control Submittals: Submit for Architect's information

1. Test Reports: Submit three (3) copies of test report, prepared by the testing agency, for each specified test showing required performance criteria and test results. Arrange with the independent testing agency to prepare test reports in accordance with reporting procedure described in the referenced test standards. Include in the test reports, detailed descriptions of modifications made to the test specimen prior to and during the tests. Reports shall include color photographs and videos of test specimens, relevant details, and testing.

2. Visual Documentation

a. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.

b. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.

c. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

d. Metadata: Record accurate date and time from camera.

e. File Names: Name media files with Project Name, Date and sequential numbering suffix.

1.6 QUALITY ASSURANCE

A. Testing Laboratory: Recognized independent AAMA approved testing agency which is equipped and experienced in conducting the required tests and approved by the Owner. The exterior enclosure manufacturer/fabricator's own test facilities and procedures will not be acceptable, except with the concurrence of the Owner, Contractor and Architect and submission of the following:

1. Manufacturer/Fabricator's having their own test facilities and who wish concurrence of its use shall state in an attachment to their proposal:

a. Description of test facilities with regard to tests specified herein.

b. Listing of prior uses of test facilities in similar projects.

c. The amount to be deducted from bid for use of manufacturer/fabricator's own test facilities.

B. Responsibility: The Owner shall retain an Independent Testing Laboratory to perform specified tests to verify proposed system’s stipulated performance. The Contractor shall be responsible for preliminary submissions, scheduling and orderly execution of tests and re-tests if necessary and shall include the complete cost of the installation of the mock up assemblies and the chamber rental fee until the final completion of testing and acceptance. Supervisory construction personnel shall be present for key erection sequences and testing.

C. Glass Manufacturer: Notify the glass manufacturer of the mock-up test program and provide the opportunity to the manufacturer to observe the tests and instrument the mock-up(s), should he so desire, provided participation causes no delays and is at no additional cost to the Owner.

D. Testing: Arrange for and have tests completed sufficiently in advance to allow incorporation of test findings and modifications into production units of final system.

E. Calibration

1. Air Leakage Calibration: Overall chamber air leakage shall be determined initially by covering the specimen to determine border and other type leakage. For each subsequent static air infiltration test scheduled, cover the wall only if gross air infiltration has, in the opinion of the Architect, changed significantly from the previous tests. The only air infiltration test that will require re-calibration and covering the specimen shall be after the thermal cycling test.

2. Aircraft Engine Calibration: Aircraft engine calibration and the engine positions for dynamic pressure water infiltration testing shall be as required by the Architect and the positions shall be marked on the slab for subsequent dynamic water test engine positioning.

3. Thermal Test Calibration: The thermal test facility shall be calibrated with a

standard calibration panel of known conductance, constructed matching requirements of AAMA 1503.1, Fig. 3 to establish cold and warm side surface coefficients. The thermal test facility shall be calibrated prior to initial testing and periodically, at least semiannually, thereafter. The facility shall also be recalibrated if changes or adjustments are made to the equipment or if test data appears questionable.

F. Pre-Test Meeting: Prior to the start of construction of mock-up assembly meet to review methods and sequence of the mock-up construction. The meeting shall include the Contractor, the Architect, the Owner's Testing Agency, the wall manufacturer/fabricator and wall erector awarded the portion of the Work related to the mock-up, related sub-subcontractors, the testing and inspection agent, and other subcontractors whose work requires coordination with this Work. Include in the meeting individual foremen who will be supervising both the Work of the Mock-ups as well the as the construction of the final Work on the Project.

G. Witnessing of Testing: Conduct tests of mock-up under the direction of an approved testing agency in the presence of the Owner, the Contractor, the wall manufacturer, the Installer, the Owner's Testing Agency and the Architect. Proceed with each test only after acceptance of the submitted detailed outline of test procedure and other required submittals.

H. Waiving of Tests: The Architect may waive any or all tests provided the wall manufacturer can furnish certified test reports by an acceptable independent testing laboratory showing that the wall as shown and specified has been previously tested and has met or exceeded the specified performance requirements. Should this certification be accepted by the Architect, an adjustment shall be made in the Contract sum and Contract time.

I. Glass Removal and Replacement: Each mock-up assembly shall contain one light of glass (in location as directed by the Architect) which is removed at the test facility and re-glazed at the test facility, in the presence of the testing agency utilizing the proposed submitted reglazing sequence.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. Laboratory Testing: Representative samples of exterior walls shall be mocked-up for visual review and performance testing at an approved testing lab. The test will be conducted for the following:

1. Air Infiltration: ASTM E283

2. Water Penetration: ASTM E331, AAMA 501.1

3. Structural Performance: ASTM E330 @ 50%

4. Live Load Deflection: Test performed at calculated loads specified

5. Interstory Drift: AAMA 501.4

6. Thermal Cycling: AAMA 501.5

7. Structural Performance: ASTM E330. Test performed at 1.5 times design pressure.

8. Seismic Racking: AAMA 501.4, ASCE 7-22

9. Site Air Infiltration and Water Penetration Tests: On-site hose tests will be performed as per AAMA 501.2 and AAMA 503.

B. Provide full-size glass samples for each specified glass type for review.

C. Visual Mock-ups to be provided for each wall type.

1. As indicated on drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF MOCK-UP, GENERAL

A. Manufacturer's Instructions: Prepare substrates, apply primers and construct the required mock-up(s), including equipment, components, and accessories in accordance with manufacturer's instructions, except where more stringent requirements are shown or specified, and where conditions require extra precautions or provisions to ensure satisfactory performance of the Work.

3.2 REQUIREMENTS PRIOR TO TESTING

A. Submittal Review: Prior to construction and testing of the mock-ups, required submittals shall have been reviewed and received final action including acceptance of compatibility testing. Preceding testing of the mock-up assembly, the removal and replacement of selected light of glass in accordance with submitted procedure, shall have been completed, documented and approved.

B. Notification of Readiness: Notify the Architect of the readiness of the mockups for preliminary and final testing. Do not begin the testing program without the presence of the Architect and the Owner’s Testing Laboratory.

1. The Architect shall perform a visual review of mock-up(s) to review fit, finish, joinery and level of craftsmanship. Items requiring correction or modification shall be documented and if necessary corrected prior to proceeding with testing.

3.3 PRELIMINARY TESTING

A. Opening, Closing and Locking Cycle Preload Test: Subject fully glazed operable metal window units to 300 complete opening, closing, and locking cycles. Correct deficiencies and damage, and repeat test to the satisfaction of the Architect.

B. Preliminary Pretest: Conduct a preliminary pretest of mock-up assembly consisting of the following:

1. Preload test chamber to one half the positive and one half the negative maximum design wind load.

2. Pretest for Air Infiltration (Static Pressure): ASTM E283 except test pressure difference shall be 6.24 psf.

3. Pretest for Water Penetration (Static Pressure): ASTM E331 with a water application rate of 5 gph/ft^2 for 15 minutes; Test to 12 psf or 20% of design load, whichever is greater.

4. Perform remedial work, if required.

5. Re-test for air and water penetration.

6. Record and submit modifications to the test assembly or individual components during pretesting of the mock-up.

C. Limitation of Pretest: The preliminary pretest is purposely limited to a single event with one correction and retest. Minor modifications to the mockup assembly will be allowed prior to the correction and retest. However major modifications (defined by the Architect) shall not be allowed. Failure to pass both the preliminary pretest and the correction and retest will require necessary redesign, resubmission of mock-up drawings and retesting for the preliminary pretest prior to Final Testing.

D. Permission for Pretest: Contractor shall not "pretest" mock-up assemblies without prior permission from the Owner and the Architect and if granted, "pretesting" shall only be performed in the presence of the Testing Laboratory’s authorized representative.

3.4 FINAL TESTING

A. Order of Testing: Make the following tests of the mock-up, in the order listed, and in accordance with performance criteria specified in Specification Section 08 03 50 "Exterior Enclosure, General" and other related specification sections.

B. Testing

1. **TBD**

C. Corrective Measures:

1. Correct deficiencies in the mock-ups observed during testing and repeat tests as may be required to show compliance with the specified performance standards

and the Contract Documents. Resubmit submittals affected by these corrections.

2. Deficiencies requiring repair or modification to the mock-up(s) shall mandate a complete retesting of the mock-up(s) beginning with the specified Preliminary Test unless otherwise directed by the Architect. If compliance with the performance standards is not achieved after 2 complete retests the Contractor shall bear costs for additional retesting including additional testing laboratory fees and other fees and expenses incurred by the Owner and Architect and their authorized representatives until compliance with the performance standards is accomplished.

3. Incorporate corrective measures indicated by the test report into the final exterior enclosure assemblies after review by the Architect.

N. Post-Test Examination of Mock-Up: After completion of the exterior enclosure mock-up(s) test, the manufacturer/fabricator shall disassemble the mock-up(s) in the presence of the Independent Testing Laboratory, to verify that it was assembled in accordance with the actioned shop drawings and agreed revisions. Any portion of the mock-up(s) which deviates from the shop drawings or agreed revisions shall be subject to retesting. The wall manufacturer/fabricator shall submit details illustrating modifications made and deviations with Final Test Report by Independent Testing Laboratory.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 – PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Exterior Performance Criteria: Comply with the requirements specified in Section 08 0350, “Exterior Enclosure - General”.

B. Thermally Rated Door Assemblies: Provide exterior door assemblies with U-factor of not more than **0.38 deg Btu/F x h x sq. ft.**when tested according to NFRC 102.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products manufactured by a member of the Steel Door Institute. Steel Door Institute Members are as follows.

1. Ceco Door.
2. Curries.
3. MPI.
4. Pioneer Industries, Inc.
5. Republic Doors & Frames.
6. Steelcraft.

2.03 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications; free from scale, pitting or other defects; stretcher leveled standard of flatness for doors

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B, with minimum G60 or A60 zinc iron alloy (galvannealed) coating, mill phosphatized; stretcher leveled standard of flatness for doors. Factory prepare metallic coated sheet steel components to receive finish painting in the field.

D. Reinforcing Steel, Supports and Anchoring Devices: Structural steel, ASTM A36/A36M; or sheet steel, ASTM A1008/A1008M cold rolled or ASTM A1011/A1011M hot rolled and ASTM A568/A568M; but not less than 16 gauge (1.5mm); hot dip galvanize after fabrication; comply with ASTM A153/A153M, Class B

E. Galvanized Sheet Steel: ASTM A653/A653M, G90 (Z275 275 g/m2) coating (minimum spangle), commercial quality, mill phosphatized; stretcher leveled standard of flatness for doors

F. Mineral Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Insulation: Manufacturer's standard, foamed-in-place, with no CFC or HCFC.

H. Fasteners: Galvanized steel.

1. Bolts and Nuts: ANSI/ASME B18.2.1, B18.2.2, and ASTM A307, Grade A; with ASTM A563/A563M hex nuts and, where indicated or required, flat washers.

2. Machine Screws: ANSI/ASME B18.6.3, and ASTM A307, carbon steel, Phillips flat head.

3. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete.

a. Hilti Fastening Systems "Kwik Bolt TZ Expansion Anchor"

b. Simpson Strong-Tie "Wedge-All Anchors"

c. Power Fasteners "Power Stud"

I. Primer Paint: A baked-on, air dried, or properly cured rust inhibiting 'direct to metal' type primer compatible with the respective specified finish paint and complying with the chemical preparation, painting, testing procedure, evaluation and acceptance criteria of ANSI/SDI A250.10.

J. Dielectric Separator SSPC Paint 12, compounded for 15 mils dry film thickness per coat; Cold applied type, inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities, non-sagging, resistant to severe corrosion conditions; applied in two coats for an overall minimum dry film thickness of 30 mils (0.8mm).

K. Grout: Comply with ASTM C476, with a slump of 4 in. for standard hollow metal door frames built into concrete or masonry, as measured according to ASTM C143.

2.04 FABRICATION, GENERAL

A. General: Fabricate doors and frames to the design and dimensions shown and scheduled in accordance with best shop practices and in compliance with SDI 117 "Manufacturing Tolerances Standard Steel Door and Frames". Unless otherwise shown or specified, fabricate doors and panels to a thickness of 1-3/4 in.. Take field measurements where coordination with adjoining work is necessary.

B. Workmanship: Fabricate the Work to the design and dimensions shown. Make strong, rigid, neat in appearance and free from defects. Form members straight and true, corners square, joints coped or mitered, and in proper alignment. Reinforce corners as required to prevent twisting or sagging. Make exposed surfaces free from warp, wave and buckle with corners square, unless otherwise shown. Form molded members straight and true, with welded joints coped or mitered, well formed, and in true alignment. Provide a full miter continuously welded on back side at frame corners with edges straight and true. Grind welds smooth and flush on exposed surfaces so they are invisible after finishing. Accurately machine, file and fit exposed connections with hairline joints. Conceal fastenings unless otherwise indicated. Dress welded joints smooth on exposed surfaces to make imperceptible after finishing.

C. Door Clearances: Provide clearances for doors, not otherwise specified or shown, as follows: 1/8 inch maximum between door and frame at jambs and heads. 1/8 inch maximum between meeting stiles of paired doors. The clearance measured from the bottom of the door to the bottom of the frame(Undercut) shall be a maximum of 3/4 inch ANSI/SDI A250.8-2017 unless otherwise specified or indicated.

1. Provide 3/8 inch maximum between door bottom and finish flooring where threshold or carpet is not required. Provide 1/4 inch clearance at door bottom above a threshold or carpet.

2. Sound-rated door undercuts shall comply with requirements of tested assemblies.

3. Fire door undercuts shall comply with ANSI/NFPA 80, *Standard for Fire Doors and Other Opening Protectives and* authorities having jurisdiction.

D. Preparation for Hardware: Mortise, reinforce, drill and tap the Work for finish hardware in accordance with the final hardware schedule and the hardware manufacturers' templates. Provide reinforcement as follows.

1. Hinge or Pivot Reinforcement: 3/16 inch thick by 1-1/2 inch x 10 inch minimum size for frames. Offset reinforcement so that faces of mortise butt hinges are flush with face of the frame rabbet and door edge.

2. Lock Front and Strike Reinforcement: 3/16 inch thick by size as required by hardware manufacturer.

3. Lock Face Reinforcement: 0.093 inch minimum thickness of uncoated steel by size as required by hardware manufacturer.

4. Closer and Holder Reinforcement: 0.093 inch minimum thickness of uncoated steel by size as required by hardware manufacturer.

5. Other Hardware Reinforcement: 0.053 inch minimum thickness of uncoated steel.

E. Provisions for Electrical Devices: Provide steel conduit, boxes and other necessary devices required for the installation of electrical hardware in doors and frames.

2.05 STEEL DOORS

A. Flush Doors: Fabricate to a thickness of 1-3/4 inch, unless otherwise noted. Construct with edges welded and finished flush, without exposed seams or joints on faces and edges. Provide continuous steel channels welded to both faces at stiles and edges of door. Place insulation material between reinforcing and completely filling the interior.

1. Exterior Flush Doors: ANSI/SDI A250.8 Level 4 and ANSI/SDI A250.4 Level A, Model Face sheets metallic coated steel 0.067 inch minimum thickness of uncoated steel. Internally reinforce with 0.020 inch minimum thickness of uncoated steel, vertical stiffeners spaced not over 6 inches apart, with laminated core and polyurethane filler. Provide flush closure at top and bottom of door.

2. Interior Flush Doors: Internally reinforce with 0.020 inch minimum thickness of uncoated steel, vertical stiffeners spaced not over 6 inches apart and spot welded to both door faces ANSI/SDI A250.8 Level 2 and ANSI/SDI A250.4 Level B, Model Face sheets 0.053 inch minimum thickness of uncoated cold-rolled steel.

B. Door Edges: Bevel the lock edge stile 1/8 inch in 2 inch (1:16) for single-acting doors.

2.06 STEEL FRAMES

A. Frame Construction: Provide combination type steel door frames to be used as both door buck and trim, formed to profiles shown. Knocked-down frames will not be accepted.

1. Exterior Frames: Thermally broken, ANSI/SDI A250.8 Level 4, galvanized steel 0.067 inch minimum thickness of uncoated steel.

2. Interior Frames: ANSI/SDI A250.8 Level 3, 0.053 inch minimum thickness of uncoated cold-rolled steel.

B. Frame Corners: Provide a full miter continuously welded on back side at corners with edges straight and true. Grind welds smooth and flush on exposed surfaces.

C. Jamb Anchors: Tee shaped, corrugated or perforated steel anchors. Fabricate anchors of same steel material and thickness as used for the frame, 2-1/2 inches wide by 10 inches long. Provide 3 anchors per jamb up to 7 feet-6 inches jamb height, and 4 per jamb for 7 feet-6 inches to 8 feet-0 inches height. For frames over 8 feet-0 inches, provide 5 anchors plus 1 additional anchor for each additional 24 inches or fraction thereof in height.

D. Fire Rated Jamb Anchors: Provide anchors for fire-rated frames as required by the authority having jurisdiction. Material and thickness of strap and anchor same as frame. Minimum anchor size, 2 inches wide by 10 inches long. Provide 2 anchors per jamb up to 5 feet-

0 inches jamb height, plus 1 additional anchor for each additional 30 inches or fraction thereof.

E. Steel Stud Anchors: Where frames are set into standard drywall or shaft wall steel studs, weld 0.053 inch minimum thickness of uncoated steel anchor clips immediately above or below hinge and strike reinforcement and at least 24 inches on center to each jamb and head. Anchor clips shall match the size and type of stud used in each wall.

F. Floor Anchors: Support frame by adjustable galvanized steel clip angles, 0.067 inch minimum thickness of uncoated cold-rolled steel, welded to frame and punched for two 3/8 inch fasteners.

G. Head Stiffener: Reinforce head of frames over 4 feet-0 inches wide with 0.067 inch minimum thickness of uncoated steel channel.

H. Dust or Mortar Guards: At concealed side of frames, weld full enclosing steel cover boxes over mortises or cutouts for hardware.

I. Holes for Rubber Door Silencers: 3 for single doors and 2 for pairs of doors. Install plastic plugs in silencer holes to keep holes clear during installation.

J. Door Frame Spreaders: Provide steel channel spreaders at the bottom of door frames to prevent distortion during shipment and storage and to hold frames in proper position until anchorage and adjacent construction has been completed.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Exterior Performance Criteria: Comply with the requirements specified in Section 08 0350, “Exterior Enclosure - General”.

2.02 INSULATED, COILING STEEL DOOR

B. Overhead Coiling Door **[OCD-01]:** Provide an insulated steel slat curtain construction, designed as weatherproof closure with spring counterbalanced open/close operation by means of electro-motorized system. Size and configuration as indicated.

1. “Thermiser” (Cornell Iron Works Inc.)

2. “Stormtite 625 Series” (Overhead Door Corp.)

3. “Rolling 6222” (Atlas Roll-Lite Door Corp.)

C. Curtain: Fabricate curtain to the design shown with interlocking flat slats of galvanized steel sheet, ASTM A653/A653M Commercial Quality, hot-dip galvanized with G90 0.90 oz./ft.2 zinc coating, mill phosphatized. Minimum 22 ga. steel facing slats and 22 ga. steel liner slats. Slats filled with rigid foam insulation, bonded to both faces and having flame spread rating of 25 or less. Equip slats with malleable iron endlocks and windlocks to guide and support curtain in track. Fabricate a bottom rail of 2 hot-dip galvanized steel angles back-to-back, fitted with continuous resilient weatherseal and safety bar.

1. Insulated to R-7 minimum.

D. Torsion-Spring Counterbalance System: Coiled steel torsion springs wound onto horizontal steel pipe shaft of size sufficient to carry door load with a deflection not to exceed 0.03 in./foot (1:400) of opening width, and ball-bearing roller mounting brackets at each end. Springs anchored to a tension rod and held in position by wheel accessible from the outside of housing. Equip counterbalance shaft with sprocket wheels for chain-driven connection to motor operator and hoist. Counterbalance shall be sized and tested to provide 100,000 open-close cycles without failure.

E. Header Box: Galvanized steel sheet construction, not less than 24 ga., with brackets and reinforcing, as required to fully enclose the door curtain and drive apparatus. Equip with resilient weatherseal baffle. Arrange means for simple access to facilitate maintenance.

F. Motorized Operating System: Construct to suit size of door for smooth and dependable open/close operation at average 1 fps (0.3 m/s) speed, without undue wear nor necessitating excessive maintenance for any part. Electrical components shall be UL labeled, housed in weatherproof enclosures, and comply with applicable code requirements.

1. Drive Apparatus: Motor-driven, sealed-gear speed reduction unit, adjustable clutch, electro-mechanical brakes, with roller chain drive. Equip with motor disconnect for manual operation, and a safety clutch device to stop motor if roller drive chain breaks.

2. Motor: Instant-reversing, sealed unit, with integral thermal and overload protection. Motors shall operate on 480 VAC, 3-phase power supply.

3. Starter: Magnetic starter with overload relay, factory wired and interlocked to motor and controlling devices, with external wiring terminal panel.

4. Limit Switches: Gear or chain driven contacts to control the “open” and “close” limits of door travel.

5. Safety Switch: Pressure contact assembly, enclosed within continuous weatherseal at bottom door edge, arranged to reverse door travel upon contacting an object while door is closing.

6. Control Stations: Pushbuttons for “open”, “close” and “stop” control. Key-locked “on/off” power switch. Refer to Section 087100 “Hardware”, for lock cylinders and keying.

7. Manual Chain Operator: Provide a mechanism for engaging a sprocket and chain operator and releasing the brake for manual use, operable from the floor. Include interlocking devices to automatically prevent the motor from operating until the manual operator or manual locking provisions are disengaged.

8. Counters: Equip each door with device to count the number of operating cycles.

G. Track: Manufacturer’s standard galvanized steel track system sized for door weight, and equipped with resilient weatherstripping for weathertight closure of door in the opening. Provide complete track assembly including brackets, closures, bracing and reinforcing for the door type and size shown.

H. Shop Painting: After completion of fabrication, clean the metal surfaces to remove dirt or other deleterious matter and chemically treat to promote adhesion of paint. Apply baked-on enamel primer to obtain uniformly smooth paint coating on inside and outside surfaces. Manufacturer’s standard baked-on type of rust-inhibiting enamel primer will be acceptable, provided that primer is compatible and suitable to receive the intended finish paint such as catalyzed epoxy enamel.

1. Finish: Exterior **– TBD**, Interior **- TBD**

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Exterior Performance Criteria: Comply with the requirements specified in Section 08 0350, “Exterior Enclosure - General”.

B. General System Description: The entrance and storefront system as described herein is that portion of the facade that comprises materials, components and assemblies between the internal and the external surfaces at the entrance level which shall be considered a complete system providing a high quality, thermally broken, watertight, airtight, and structurally sound entrance and storefront enclosure to the specified standards.

2.02 MATERIALS

A. Aluminum-Framed Entrance and Storefront Systems: Subject to compliance with requirements, provide aluminum-framed entrance and storefront systems by one (1) of the following, or approved equal:

B. Basis of Design: “Model/Product **TBD**” (YKK Architectural Products)

1. Or equal by Kawneer, Old Castle Building Envelope, or Wausau Window and Wall Systems.

C. Frames and Mullions:

1. Metal/Finish: Painted Aluminum Finish (AMAA 2605)

2. Manufacturer: Sherwin Williams

3. Color: “Steel Horizon”

4. Type: Fluropon Classic II

2.03 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Sealants: As specified in Section 07 9000 “Joint Sealant”.

B. Hardware: As specified herein and in Section 08 7100 “Hardware”.

C. Glass and Glazing: As specified in Section 08 8000 “Glazing”.

D. Stainless Steel Flashing: ASTM A666, Type 304, dead soft fully annealed except where harder temper required for forming or performance; 0.015 in. (28 gage) thick unless otherwise shown, finish No. 2D. Provide 60 - 40 tin/lead solder, with acid chloride type flux, except use rosin flux over tinned surfaces in accordance with ASTM B32.

E. Slip Gaskets (at bolted slip-joints in skylight): Non-metallic, low friction material (high impact polystyrene or nylatron) having the temperature resistance, moisture resistance and low abrasion properties as required to suit performance criteria

1. Provide "Eel-Slip Pads" (Scan-Pac), or approved equal.

F. Separator Gaskets (except at bolted slip-joints): Non-corrosive, non-toxic impregnated felt or butyl tape with pressure sensitive adhesive on one surface which is formulated for proper adhesion to metals specified, thickness and width as required. Gaskets shall contain temperature and moisture properties as required to suit specified performance criteria

G. Thermal Separators: Polyamide, 50 Shore A durometer hardness +/- 5 or poured homogeneous structural polyurethane of a cross sectional profile, interlocking with aluminum extrusions (minimum 3/8 in. separation) forming an integral structural unit

H. Weep Baffles: PVC coated, reticulated, flexible open cell reticulated polyurethane foam; 30-40 pores per 1-in. or as recommended by the fabricator. PVC coating shall have a bacteriostat additive added to the formulation

1. Provide "PVC Coated SIF-G Industrial Foam" (Foamex Corp.) or approved equal.

I. Welding Electrodes: Type and alloy recommended by the producer of the metal to be welded and as required for color match, strength and compatibility in the fabricated items

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Exterior Performance Criteria: Comply with the requirements specified in Section 08 0350, “Exterior Enclosure - General”.

B. General System Description: The curtain wall system(s) as described herein include materials, components, and assemblies. The curtain wall and glazed assemblies shall provide a high quality, watertight, airtight and structurally sound building enclosure to the specified standards.

1. Drawings and details are diagrammatic and are intended to show design concept, configuration, components and arrangements; they are not intended to identify nor solve completely problems of thermal and structural movements, air pressure equalization, air and vapor barriers, assembly framing, fixings and anchorages, moisture disposal, water penetration and problems at the glass line associated with glazing installation, movements, pressure fracture or thermal shock and weather seal.

2. Final engineering design of curtain wall system(s) is responsibility of this trade. Material types, sizes and/or thicknesses shown on Drawings are minimums acceptable and shall not be reduced regardless of engineering design.

2.02 MATERIALS

A. Unitized, aluminum framed, structurally glazed (with pressure caps where indicated), insulated and spandrel glass curtain wall system with concealed reinforcing as required. Provide details and dimensions allowing for field adjustments and thermal movement. Operable windows where indicated on drawings.

1. Basis of Design: 2 Sided Capture System by YKK Architectural Products

    a. Or equal by Kawneer, Old Castle Building Envelope, or Wausau Window and Wall Systems.

2. Mullions:

    a. Metal/Finish: Painted Aluminum Finish (AMAA 2605)
    b. Manufacturer: Sherwin Williams
    c. Color: “Steel Horizon”

d. Type: Fluropon Classic II

2.03 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Sealants: As specified in Section 07 9000 Joint Sealants.

B. Glass and Glazing: As specified in Section 08 8000 Glazing.

C. Thermal Separators: Provide thermal break by a continuously extruded, multi-directional 25% glass fiber reinforced 6/6 polyamide nylon strip. Aluminum framing members separated up to a maximum of 3-in. (75mm) with a locking mechanical connection to the thermal strip(s) by knurling the aluminum cavity and crimping the strip(s) into place to create a composite thermal barrier assembly. Structural performance values of the Thermal Barrier assembly to meet specific product/project design criteria or at a minimum certified testing criteria and procedures as described by the AAMA TIR-A8 performance standards.

D. Silicone Sheet Flashing: Low-modulus clear silicone extrusion formed into uniform flexible sheets not less than 1/16 in. thick, by required width.

1. Provide one of the following:

a. “E70-5410-1, Silicone Rubber” (Elbex)
b. “DOWSIL 123 Silicone Seal” (Dow Corporation)
c. “UltraSpan US1100” (Momentive/General Electric Silicones).

E. Silicone Sheet Flashing Adhesive: Type recommended by silicone sheet flashing manufacturer for waterproof, weather resistant seaming. Adhesive shall be compatible with materials to which it is bonded and in contact with. Provide appropriate color of adhesive to prevent staining of substrates.

F. Stainless Steel Flashing: ASTM A666, Type 304, dead soft fully annealed except where harder temper required for forming or performance; 0.015-in. (28 gage) thick unless otherwise shown, finish No. 2D. Provide 60/40 tin/lead solder, with acid chloride type flux, except use rosin flux over tinned surfaces in accordance with ASTM B32.

G. Slip Gaskets (at bolted slip-joints in exterior curtain wall): Non-metallic, low friction material (high impact polystyrene or nylatron) having the temperature resistance, moisture resistance and low abrasion properties as required to suit performance criteria.

1. Provide “Eel-Slip Pads” (Scan-Pac), or equal.

H. Separator Gaskets (except at bolted slip-joints): Non-corrosive, non-toxic impregnated felt or butyl tape with pressure sensitive adhesive on one surface which is formulated for proper adhesion to metals specified, thickness and width as required. Gaskets shall contain temperature and moisture properties as required to suit specified performance criteria.

1. Provide the "No. 162 Elastic Compound Tape" (Presstite Division of United

Technologies), or equal.

I. Weep Baffles: PVC coated, reticulated, flexible open cell reticulated polyurethane foam; 30-40 pores per 1 in.or as recommended by the fabricator. PVC coating shall have a bacteriostat additive added to the formulation.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Exterior Performance Criteria: Comply with the requirements specified in Section 08 0350, “Exterior Enclosure - General”.

2.02 MATERIALS

B. Thermally Broken Window System **[WND-01]:** Provide operable capabilities as indicated on drawings and in window schedule. Accommodate insulated glazing units.

1. Basis of Design: “Model/Product **TBD**” (YKK Architectural Products)

   a. Or equal by Kawneer, Old Castle Building Envelope, or Wausau Window and Wall Systems.

2. Frames:

   a. Metal/Finish: Painted Aluminum Finish (AMAA 2605)
   b. Manufacturer: Sherwin Williams
   c. Color: “Steel Horizon”
   d. Type: Fluropon Classic II

2.03 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Sealants: As specified in Section 07 9000 Joint Sealants.

B. Glass and Glazing: As specified in Section 08 8000 Glazing.

C. Thermal Separators: Provide thermal break by a continuously extruded, multi-directional 25% glass fiber reinforced 6/6 polyamide nylon strip. Aluminum window framing members separated up to a maximum of 3-in. (75mm) with a locking mechanical connection to the thermal strip(s) by knurling the aluminum cavity and crimping the strip(s) into place to create a composite thermal barrier assembly. Structural performance values of the Thermal Barrier assembly to meet specific product/project design criteria or at a minimum certified testing criteria and procedures as described by the AAMA TIR-A8 performance standards.

D. Weatherstripping: AAMA 701 and AAMA 702 "Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals." Provide compressible,

removable and replaceable type weatherstripping formed from neoprene or EPDM complying with ASTM D2000 or molded expanded EPDM or neoprene complying with ASTM C509, grade as selected by the manufacturer.

E. Stainless Steel Flashing: ASTM A666, Type 304, dead soft fully annealed except where harder temper required for forming or performance; 0.015-in. (28 gage) thick unless otherwise shown, finish No. 2D. Provide 60 40 tin/lead solder, with acid chloride type flux, except use rosin flux over tinned surfaces in accordance with ASTM B32.

F. Weep Baffles: PVC coated, reticulated, flexible open cell reticulated polyurethane foam; 30-40 pores per 1 in.or as recommended by the fabricator. PVC coating shall have a bacteriostat additive added to the formulation.

G. Hardware for Operable Windows: AAMA Series 900 for hardware appropriate to each specified type window. Provide manufacturer's standard or custom design for operation specified; fabricated of stainless steel complying with ASTM A167 or ASTM A666 or white bronze and finished to match frame of window.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware
2. Electronic access control system components

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 "General Requirements" sections for Allowances, Alternates, Owner Furnished Contractor Installed, Project Management and Coordination.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
   a. "Metal Doors and Frames"
   b. "Flush Wood Doors"
   c. "Interior Aluminum Doors and Frames"
   d. "Aluminum-Framed Entrances and Storefronts"
6. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL LLC

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
   a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
   b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
   a. Wiring Diagrams: For power, signal, and control wiring and including:
      1) Details of interface of electrified door hardware and building safety and security systems.
      2) Schematic diagram of systems that interface with electrified door hardware.
      3) Point-to-point wiring.
      4) Risers.

3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.

a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.

4. Door Hardware Schedule:
   a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
   b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
   c. Indicate complete designations of each item required for each opening, include:
      1) Door Index: door number, heading number, and Architect's hardware set number.
      2) Quantity, type, style, function, size, and finish of each hardware item.
      3) Name and manufacturer of each item.
      4) Fastenings and other pertinent information.
      5) Location of each hardware set cross-referenced to indications on Drawings.
      6) Explanation of all abbreviations, symbols, and codes contained in schedule.
      7) Mounting locations for hardware.
      8) Door and frame sizes and materials.
      9) Degree of door swing and handing.
      10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

5. Key Schedule:
   a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
   b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
   c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
   d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
   e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
   f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
   b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
   a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.
   c. Final approved hardware schedule edited to reflect conditions as installed.
   d. Final keying schedule
   e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
   f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
   a. Fire door assemblies, in compliance with NFPA 80.
   b. Required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
   a. For door hardware: DHI certified AHC or DHC.
   b. Can provide installation and technical data to Architect and other related subcontractors.
   c. Can inspect and verify components are in working order upon completion of installation.
   d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.

4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:
    a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
    b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

2. Smoke and Draft Control Door Assemblies:
    a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
    b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.

3. Electrified Door Hardware
    a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

4. Accessibility Requirements:
    a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference
    a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
        1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
        2) Preliminary key system schematic diagram.
        3) Requirements for key control system.
        4) Requirements for access control.
        5) Address for delivery of keys.

2. Pre-installation Conference
    a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
    b. Inspect and discuss preparatory work performed by other trades.
    c. Inspect and discuss electrical roughing-in for electrified door hardware.
    d. Review sequence of operation for each type of electrified door hardware.
    e. Review required testing, inspecting, and certifying procedures.
    f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:
    a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.

C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.

D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.07 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.

1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
    a. Mechanical Warranty
        1) Locks
            a) Schlage ND Series: 10 years
        2) Exit Devices

a) Von Duprin: 10 years
3) Closers
a) LCN 4000 Series: 30 years
4) Automatic Operators
a) LCN: 2 years
b. Electrical Warranty
1) Locks
a) Schlage: 3 years
2) Exit Devices
a) Von Duprin: 3 years

1.08 MAINTENANCE

A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approval of alternate manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category are only to be considered by official substitution request in accordance with section 01 25 00.

B. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.

C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer’s recognized installation standards for application intended.
2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.

3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with “Metal Doors and Frames”, “Flush Wood Doors”, “Stile and Rail Wood Doors” to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.

B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

C. Cable and Connectors:

1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Ives 5BB series

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
   a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
   b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
   a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
6. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   a. Steel Hinges: Steel pins
   b. Out-Swinging Exterior Doors: Non-removable pins
   c. Out-Swinging Interior Lockable Doors: Non-removable pins

8. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 CONTINUOUS HINGES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

B. Requirements:

1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.05 ELECTRIC POWER TRANSFER

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. Von Duprin EPT-10

B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.06 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.07 COORDINATORS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

B. Requirements:

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes, or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.08 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage ND series

2. Acceptable Manufacturers and Products:
   a. Sargent 11-Line

B. Requirements:

1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide escutcheon with lock status indicator window on top of lockset rose:
   a. Escutcheon height (including rose) 6.05 inches high by 3.68 inches wide.
   b. Indicator window measuring a minimum 3.52-inch by .60 inch with 1.92 square-inches of front facing viewing area and 180-degree visibility with a total of .236 square-inches of total viewable area.
   c. Provide snap-in serviceable window to prevent tampering. Lock must function if indicator is compromised.

d. Provide messages color-coded with full text and symbol, as scheduled, for easy visibility.
e. Unlocked and Unoccupied message will display on white background, and Locked and Occupied message will display on red background.

3. Cylinders: Refer to "KEYING" article, herein.
4. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2-inch latch throw. Provide proper latch throw for UL listing at pairs.
5. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
6. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
7. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
8. Provide electrified options as scheduled in the hardware sets.
9. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
   a. Vandlgard: Provide levers with vandal resistant technology for use at heavy traffic or abusive applications.
   b. Lever Design: LATITUDE

2.09 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Von Duprin 99/33A series

2. Acceptable Manufacturers and Products:
   a. Sargent 19-43-GL-80 series

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide grooved touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer's approved strikes.
9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder or hex-key dogging as specified at non fire-rated openings.

12. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
13. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
14. Provide electrified options as scheduled.
15. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
16. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.10 ELECTRONIC ACCESS CONTROL LOCKSETS AND EXIT DEVICE TRIM

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. Schlage CO Series

B. Requirements:

1. Provide offline electronic access control products that comply with the following requirements:
   a. Listed, UL 294 - The Standard of Safety for Access Control System Units.
   b. Compliant with ANSI/BHMA A156.25 Grade 1 Operation and Security.
   c. Certified to UL10C, FCC Part15, Florida Building Code Standards TAS 201 large missile impact, TAS 202 and TAS 203.
   d. Compliant with ASTM E330 for door assemblies.
   e. Compliant with ICC / ANSI A117.1, NFPA 101, NFPA 80, and Industry Canada RSS-210.

2. Functions: Provide functions as scheduled that are field configurable without taking the offline electronic product off the door.
3. Emergency Override: Provide mechanical key override; cylinders: Refer to "KEYING" article, herein.
4. Levers:
   a. Vandal Resistance: Exterior (secure side) lever rotates freely while door remains locked, preventing damage to internal lock components from vandalism by excessive force.
   b. Provide pressure cast zinc plated, non-handed lever trim that operates independently of non-locking levers.
   c. Style: LATITUDE

5. Power Supply: 4 AA batteries
   a. Provide electronic access control locks and/or exit device trim with the ability to communicate battery status.

6. Features:
   a. Visual tri-colored LED indicators that indicate activation, operational systems status, system error conditions and low power conditions.
   b. Visual bi-colored LED indicator on interior that can indicate secured/unsecured status of device to occupants on interior.

c. Audible feedback that can be enabled or disabled.
d. Onboard processor with memory capacity of 2,000 event audit history, up to 16 time zones and up to 32 calendar events.
e. Central verification time of less than 1 second
f. Tamper-Resistant Screws: Tamper torx screws on inside escutcheon for increased security.

7. Access:
   a. Programmable Keypad
      1) 3-6-digit PIN code and 12 backlit buttons in a 3 x 4 matrix.
   b. Magnetic Stripe
      1) Reader: triple track (1, 2, or 3) and field configurable
   c. Proximity
      1) 125kHz frequency with a read range up to 1.25 inches.
      2) Compatible credentials: 125kHz clamshell/fob, ISO card, key fob, PVC disk
      3) Compatible manufacturers: Schlage, ISONAS, HID, GE/CASI, AWID

8. Operation:
   a. Provide electronic access control locks and/or exit device trim with the ability to be configured at door by handheld programming device the length of time device is unlocked upon access grant.
   b. Provide electronic access control locks and/or exit device trim with the ability to communicate identifying information such as firmware versions, hardware versions, serial numbers, and manufacturing dates by handheld programming device.

9. Programming Means:
   a. Product: Schlage HHD series with Utility Software. (REQUIRED for all CO-series except CO-100)
      1) Provide Handheld Programming Device for adaptable electronic access control products capable of the following minimum requirements.
         a) Capable of initializing lock and accessories using preloaded software.
         b) Utilized to field configure electronic access control devices, download firmware updates, collect audit files from access control device, and set date/time.

2.11 ACCESS CONTROL READER

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage MT Series

B. Requirements:

1. Provide access control card readers manufactured by a global company who is a recognized leader in the production of access control devices. Card reader manufactured for non-access control applications are not acceptable
2. Provide multi-technology contactless readers complying with ISO 14443.
3. Provide access control card readers capable of reading the following technologies:
   a. CSN - DESFire® CSN, HID iCLASS® CSN, Inside Contactless PicoTag® CSN, ST Microelectronics® CSN, Texas Instruments Tag-It®, CSN, Phillips I-Code® CSN

b. 125 KHz proximity - Schlage® Proximity, HID® Proximity, GE/CASI® Proximity, AWID® Proximity, LenelProx®
c. 13.56 MHz Smart card - Schlage smart cards using MIFARE Classic® EV1, Schlage smart cards using MIFARE Plus®, Schlage smart cards using MIFARE® DESFire® EV1, Schlage smart cards using MIFARE® DESFire® EV2/EV3

2.12 ACCESS CONTROL PLATFORM

A. Manufacturers and Products:

1. Scheduled Manufacturer:
   a. Schlage Engage Commercial

B. Requirements:

1. Provide a cloud-based platform capable of managing users, credentials, access rights, schedules, and audits.
2. All locks must be supplied in construction mode.
3. Provide a platform that supports a mobile application (app). Mobile application must allow for:
   a. Commissioning and configuring devices
   b. Immediately updating door files
   c. Retrieving audit information
   d. Performing firmware updates

4. Provide software set up on the owner's workstation and Mobile Device which includes:
   a. Creation of the Owner's Account
   b. Creation of the Project Site
   c. Creation of the Team as directed by the Owner
   d. Addition of five users
   e. Set up of MT20W and update firmware
   f. Create unique credentials and verify proper commissioning of ten locks

5. Provide, at the owner's request, the following on-site training prior to the expiration of the service agreement:
   a. Completing the following with ENGAGE software:
      1) Modifying the Team
      2) Move in/move out procedure including
         a) Adding and Deleting Users
         b) Adding and Deleting Doors
      3) Adding, assigning and programming credentials for access
      4) Replacing or deleting lost credentials.
      5) Retrieving and viewing of audit information
      6) Assigning temporary access
   b. Commissioning and verifying proper functioning between locks and credentials.
   c. Updating firmware on the locks.

6. Must include a service agreement ending a year after Substantial Completion. This service agreement includes being on-site up to 16 hours for set-up and training, as listed above.

2.13 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage/Von Duprin PS900 Series

B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:
   a. 12/24 VDC Output, field selectable.
   b. Class 2 Rated power limited output.
   c. Universal 120-240 VAC input.
   d. Low voltage DC, regulated and filtered.
   e. Polarized connector for distribution boards.
   f. Fused primary input.
   g. AC input and DC output monitoring circuit w/LED indicators.
   h. Cover mounted AC Input indication.
   i. Tested and certified to meet UL294.
   j. NEMA 1 enclosure.
   k. Hinged cover w/lock down screws.
   l. High voltage protective cover.

2.14 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage Everest 29 T

2.15 CYLINDERS

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. FSIC CORE

B. Requirements:

1. Provide cylinders/cores to match Owner’s existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer’s series as indicated. Refer to “KEYING” article, herein.

2.16 KEYING

A. Scheduled System:

1. New factory registered system:
   a. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Construction Keying:
   a. Replaceable Construction Cores.
      1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
         a) 3 construction control keys
         b) 12 construction change (day) keys.
      2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2. Permanent Keying:
   a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
      1) Master Keying system as directed by the Owner.
   b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
   c. Provide keys with the following features:
      1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
      2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
      3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
   d. Identification:
      1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
      2) Identification stamping provisions must be approved by the Architect and Owner.
      3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
      4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
      5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
   e. Quantity: Furnish in the following quantities.
      1) Permanent Control Keys: 3.
      2) Master Keys: 6.
      3) Change (Day) Keys: 3 per cylinder/core that is keyed differently
      4) Key Blanks: Quantity as determined in the keying meeting.

2.17 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Telkee

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
   a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
   b. Provide hinged-panel type cabinet for wall mounting.

2.18 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. LCN 4040XP series

2. Acceptable Manufacturers and Products:
   a. Sargent 281 series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.

9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.
11. Closers shall be capable of being upgraded by adding modular mechanical or electronic components in the field.

2.19 ELECTROMECHANICAL AUTOMATIC OPERATORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. LCN Senior Swing

B. Requirements:

1. Provide low energy automatic operator units that are electromechanical design complying with ANSI/BHMA A156.19.
   a. Opening: Powered by DC motor working through reduction gears.
   b. Closing: Spring force.
   c. Manual, hydraulic, or chain drive closers: Not permitted.
   d. Operation: Motor is off when door is in closing mode. Door can be manually operated with power on or off without damage to operator. Provide variable adjustments, including opening and closing speed adjustment.
   e. Cover: Aluminum.

2. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay adjustable from 1 to 32 seconds, and logic terminal to interface with accessories, mats, and sensors.
3. Provide drop plates, brackets, and adapters for arms as required to suit details.
4. Provide motion sensors and/or actuator switches, and receivers for operation as specified. Provide weather-resistant actuators at exterior applications.
5. Provide key switches, with LED's, recommended and approved by manufacturer of automatic operator as required for function as described in operation description of hardware sets. Cylinders: Refer to "KEYING" article, herein.
6. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.

2.20 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.21 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.22 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:
   a. Glynn-Johnson

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.

2.23 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.24 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2.25 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

B. Scheduled Manufacturer:

1. Zero International

C. Seals and Gasketing: Provide continuous gasketing on exterior openings, to the head and jambs, forming a continuous seal between the door and the frame. Provide smoke, light, or sound gasketing on interior doors where indicated.

1. Provide self-tapping fasteners for aluminum extruded gasketing being applied to hollow metal frames.
   a. Provide non-corrosive fasteners for all exterior applications.
   b. Provide security fasteners where indicated.

2. Provide neoprene, EPDM, silicone, or nylon brush inserts as specified in hardware sets. Provide non brush inserts of solid or sponge cell, as specified in hardware sets. Vinyl inserts are not allowed except where specified in hardware sets.

D. Smoke Labeled Gasketing: At all smoke labeled openings, provide smoke listed perimeter gasketing assemblies complying with NFPA 105 listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for smoke control ratings indicated based on testing according to UL 1784.

E. Fire Listed Gasketing: Assemblies complying with NFPA 80 that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction for fire ratings indicated based on testing according to UL-10C.

1. Where frame-applied intumescent seals are required by the manufacturer, provide gaskets that comply with UL10C Standard for Positive Pressure Fire Tests of Door Assemblies and UBC 7-2, Fire Tests of Door Assemblies.

F. Sound-Rated Gasketing: Provide acoustic gasketing to meet Sound Transmission Class (STC) rating required.

G. Meeting-Stile Gasketing: Provide meeting-stile gasketing that fastens to the meeting stiles forming a continuous seal when doors are closed.

H. Door Sweeps or Shoes: Apply to the bottom of the door to close the gap between the door bottom and finished floor or saddle threshold.

1. Provide solid neoprene, EPDM, silicone, or nylon brush type of seal as specified in hardware sets. Vinyl inserts are not allowed except where specified in hardware sets.

I. Automatic Door Bottoms:

1. Provide closed cell sponge, bulb neoprene. or EPDM type of seal as specified in hardware sets.
2. Door bottom to be mortised, semi mortised, or surface mount as with a minimum thickness as specified in hardware sets.

J. Rain Drips:

1. Provide overhead rain drips for out-swinging hollow metal doors that are not covered against 45 degree blowing rain. Aluminum extrusion to be a minimum of .088 inches thick and extend 2.50 inches from the face of the frame, in anodized finish to match door.
2. Door sweeps or shoes with integral rain drip must meet ADA requirements

K. Thresholds: Provide threshold units not less than 4 inches wide, formed to accommodate change in floor elevation where indicated, and fabricated to accommodate door hardware and fit door frames.

1. Threshold extrusion to be a minimum thickness as specified in hardware sets.

2.26 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Schlage

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.27 COAT HOOKS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

B. Provide coat hooks as specified.

2.28 FINISHES

A. FINISH: BHMA 626/652 (US26D); EXCEPT:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Latch Protectors: BHMA 630 (US32D)
9. Weatherstripping: Clear Anodized Aluminum
10. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
4. Installation Guide for Doors and Hardware: DHI TDH-007-20

B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.

C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.

I. Lock Cylinders:

1. Install construction cores to secure building and areas during construction period.
2. Replace construction cores with permanent cores as indicated in keying section.
3. Furnish permanent cores to Owner for installation.

J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:

1. Conduit, junction boxes and wire pulls.
2. Connections to and from power supplies to electrified hardware.
3. Connections to fire/smoke alarm system and smoke evacuation system.
4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
5. Connections to panel interface modules, controllers, and gateways.
6. Testing and labeling wires with Architect's opening number.

K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

L. Continuous Hinges: Re-locate the door and frame fire rating labels where they will remain visible so that the hinge does not cover the label once installed.

M. Door Closers & Auto Operators: Mount closers/operators on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers/operators so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

N. Overhead Stops/Holders: Mount overhead stops/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

O. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

P. Thresholds:

1. Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
2. Aluminum thresholds to be cut-in, and scribed around mullions, frame members, and stops. Do not butt to thresholds. Provide a continuous surface across full width of opening from jamb to jamb.
3. Where aluminum panic-type (rabbeted) thresholds with neoprene inserts are specified, undercut doors as required to properly mate with seal in threshold.

Q. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

R. Perimeter Gasketing:

1. Apply to head and jamb, forming seal between door and frame.
2. Install gasketing in a manner eliminating need to cut any seal to install surface mounted hardware. Install compatible mounting bracket for surface mounted hardware unless minimum 1/4 inch thick solid aluminum seals are provided for mounting of surface applied hardware.

S. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

T. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items per manufacturer's instructions to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.

C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

D. Hardware Sets:

144578 OPT0463811 Version 1

Hardware Group No. 001

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
	EA	NOTE	ALL HARDWARE BY ELIASON DOOR MANUFACTURER		

Hardware Group No. 002

Provide each SL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
	EA	NOTE	ALL HARDWARE BY DOOR MANUFACTURER		

Hardware Group No. 103GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 103T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64/SR65 AS REQ	GRY	IVE

Hardware Group No. 201

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 201GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 201T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 201TW

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 205T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

Hardware Group No. 341

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	ND40S LAT OS-OCC	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

-OCCUPIED/VACANT INDICATOR ON OUTSIDE OF DOOR.

Hardware Group No. 341GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	ND40S LAT OS-OCC	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

-OCCUPIED/VACANT INDICATOR ON OUTSIDE OF DOOR.

Hardware Group No. 341T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	ND40S LAT OS-OCC	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

-OCCUPIED/VACANT INDICATOR ON OUTSIDE OF DOOR.

Hardware Group No. 347T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	ND40S LAT OS-OCC	626	SCH
1	EA	OH STOP	900S SERIES X SIZE & MTG AS REQ	652	GLY
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

-OCCUPIED/VACANT INDICATOR ON OUTSIDE OF DOOR.

Hardware Group No. 501GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	CLASSROOM LOCK	ND70TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 501T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	CLASSROOM LOCK	ND70TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 503S

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	CLASSROOM LOCK	ND70TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	OH STOP	900S SERIES X SIZE & MTG AS REQ	630	GLY
3	EA	SILENCER	SR64/SR65 AS REQ	GRY	IVE

Hardware Group No. 503SG

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	CLASSROOM LOCK	ND70TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	OH STOP	900S SERIES X SIZE & MTG AS REQ	652	GLY
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 503T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	CLASSROOM LOCK	ND70TD LAT	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64/SR65 AS REQ	GRY	IVE

Hardware Group No. 730C1GR

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9947-L-BE-F-LBRAFL-LAT LENGTH & HEIGHT AS REQ	626	VON
1	EA	FIRE EXIT HARDWARE	9947-L-BE-F-LBR-LAT LENGTH & HEIGHT AS REQ	626	VON
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	MEETING STILE	328AA (2 PCS - 1 SET) HEIGHT AS REQUIRED	AA	ZER
1	EA	GASKETING	488SBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 730C1GRT

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9947-L-BE-F-LBRAFL-LAT LENGTH & HEIGHT AS REQ	626	VON
1	EA	FIRE EXIT HARDWARE	9947-L-BE-F-LBR-LAT LENGTH & HEIGHT AS REQ	626	VON
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	MEETING STILE	328AA (2 PCS - 1 SET) HEIGHT AS REQUIRED	AA	ZER
1	EA	GASKETING	488SBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 730C1T

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	PANIC HARDWARE	9947-L-BE-LBR-LAT LENGTH & HEIGHT AS REQ	626	VON
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
2	EA	SILENCER	SR64/SR65 AS REQ	GRY	IVE

Hardware Group No. 730CGR

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9947-L-BE-F-LBRAFL-LAT LENGTH & HEIGHT AS REQ	626	VON
1	EA	FIRE EXIT HARDWARE	9947-L-BE-F-LBR-LAT LENGTH & HEIGHT AS REQ	626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	SET	MEETING STILE	328AA (2 PCS - 1 SET) HEIGHT AS REQUIRED	AA	ZER
1	EA	GASKETING	488SBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 731GRT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	99-L-BE-F-LAT-499F LENGTH AS REQ	626	VON
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 800AV

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	DUMMY PUSH BAR	330 LENGTH AS REQ	626	VON
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		

Hardware Group No. 800CGHT

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	LONG DOOR PULL	(1 SET) PR 9266F 36" (MOUNT BACK TO BACK)	630	IVE
2	EA	SURFACE CLOSER	4040XP SHCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	MEETING STILE	383AA LENGTH & HEIGHT AS REQ	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

Hardware Group No. 801

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16" F	630	IVE
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64/SR65 AS REQ	GRY	IVE

Hardware Group No. A800AV

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	DUMMY PUSH BAR	330 LENGTH AS REQ	626	VON
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 MS AS REQ (120/240 VAC)	ANCLR	LCN
2	EA	ACTUATOR, TOUCH	8310-853T	630	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		

-INGRESS OR EGRESS BY THE ACTUATOR.
-INGRESS BY THE PULLS.
-FREE EGRESS BY THE PUSH PADS.

Hardware Group No. AC714A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9947-EO-CON 24 VDC LENGTH & HEIGHT AS REQ	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9947-NL-OP-110MD-CON 24 VDC LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 MS AS REQ (120/240 VAC)	ANCLR	LCN
2	EA	ACTUATOR, TOUCH	8310-853T	630	LCN
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		
2	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
2	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
2	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-4RL 900-BBK 120/240 VAC (OMIT 4RL BOARD WHERE NOT REQ)		VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE ACTUATOR OR THE PUSH PADS.
-THE ELECTRIFIED LATCH BOLTS WILL BE SEQUENCED WITH THE AUTOMATIC OPENER AND RETRACT PRIOR TO THE AUTOMATIC OPENER ACTIVATING.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C201CT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	ND80TDEU LAT CON 12V/24V DC	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C201GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	ND80TDEU LAT CON 12V/24V DC	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C201T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	ND80TDEU LAT CON 12V/24V DC	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C205TW

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5 NRP	630	IVE
1	EA	EU STOREROOM LOCK	ND80TDEU LAT CON 12V/24V DC	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C207GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	ND80TDEU LAT CON 12V/24V DC	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	OH STOP	900S SERIES X SIZE & MTG AS REQ	652	GLY
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C714RTW

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-QEL-9947-DT-F-CON 24 VDC LENGTH & HEIGHT AS REQ	626	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-QEL-9947-NL-F-CON 24 VDC LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	GASKETING	328AA H & J	AA	ZER
1	SET	MEETING STILE	8193AA (2 PCS - 1 SET)	AA	ZER
2	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
2	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
2	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)		VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PADS.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C715T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-NL-CON-SNB LENGTH AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)		VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PAD.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C715TW

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-NL-CON-SNB LENGTH AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)		VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PAD.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. C770CRT

Provide each UEP door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	AUTO FLUSH BOLT	FB31P/FB41P AS REQ	630	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	ELEC FIRE EXIT HARDWARE	RX-QEL-9975-NL-F-CON 24 VDC LENGTH & HEIGHT AS REQ	626	VON
1	EA	MORTISE CYLINDER (AR CAM)	20-062 ICX W/KEYED CONST. CORE	626	SCH
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	COORDINATOR	COR X FL X MB X HW PREPS X LENGTH AS REQ	628	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	SET	MEETING STILE	328AA (2 PCS - 1 SET) HEIGHT AS REQUIRED	AA	ZER
1	EA	GASKETING	488SBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER
2	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
2	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	MULTITECH READER	MTB11/MTB15 12VDC AS REQ	BLK	SCE
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PAD.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

Hardware Group No. D724A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	PANIC HARDWARE	9947-EO LENGTH & HEIGHT AS REQ	626	VON
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	AA	ZER
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		
2	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE

-DOOR CONTACTS FOR MONITORING.
-NO RX PROVIDED IN EXIT DEVICES.
-EXIT ONLY. NO ENTRY.

Hardware Group No. DK201T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ELEC CLASSROOM LOCK	CO-100-CY-70-KP-LAT-J 4B BATTERY OPERATED	626	SCE
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	ORG	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE

-INGRESS BY THE KEYPAD OR KEY OVERRIDE.
-FREE EGRESS BY THE LEVER.

Hardware Group No. DOOR NOT FOUND

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR

Hardware Group No. K201GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ELEC CLASSROOM LOCK	CO-100-CY-70-KP-LAT-J 4B BATTERY OPERATED	626	SCE
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	ORG	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

-INGRESS BY THE KEYPAD OR KEY OVERRIDE.
-FREE EGRESS BY THE LEVER.

Hardware Group No. K201T

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ELEC CLASSROOM LOCK	CO-100-CY-70-KP-LAT-J 4B BATTERY OPERATED	626	SCE
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	ORG	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

-INGRESS BY THE KEYPAD OR KEY OVERRIDE.
-FREE EGRESS BY THE LEVER.

Hardware Group No. K301GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ELEC PRIVACY LOCK	CO-100-CY-40-KP-LAT-J 4B BATTERY OPERATED	626	SCE
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	ORG	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

-INGRESS BY THE KEYPAD OR KEY OVERRIDE.
-FREE EGRESS BY THE LEVER.

Hardware Group No. K307GT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	ELEC PRIVACY LOCK	CO-100-CY-40-KP-LAT-J 4B BATTERY OPERATED	626	SCE
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	ORG	SCH
1	EA	OH STOP	900S SERIES X SIZE & MTG AS REQ	652	GLY
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

-INGRESS BY THE KEYPAD OR KEY OVERRIDE.
-FREE EGRESS BY THE LEVER.

Hardware Group No. K711GRT

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 (NRP AT ALL LOCKABLE OUTSWINGING DOORS).	652	IVE
1	EA	FIRE EXIT HARDWARE	99-EO-F-SNB LENGTH AS REQ	626	VON
1	EA	ELEC EXIT DEVICE TRIM	CO-100-993R-70-KP-LAT-J 4B BATTERY OPERATED	626	SCE
1	EA	FSIC PERMANENT CORE	23-030	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	ORG	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA TBWMS X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	544A-223	A	ZER

-INGRESS BY KEYPAD OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PAD.

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 DESIGN AND PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction

B. Provide glass in conformance with requirements of the specified standards. The acceptable color and/or defects as defined by the specified standards shall be determined by samples of such defects and/or color. Glass which does not match the accepted sample shall be subject to rejection by the Architect. In the event such samples are not or cannot be furnished, the Architect will determine the acceptability of glass relative to color and/or observable defects in each case. Comply with ASTM C1036 unless otherwise specified. Type and thickness as shown or specified.

2.02 GLAZING SCHEDULE

A. Glazing Unit **[GL-01]:**

B. Glazing Unit Make-up **(To Be Confirmed):**

1. 1/4” Low Iron Heat Strengthened Glass
2. +0.06” PVB
3. +1/4” Low Iron Heat Strengthened Glass with low-e coating on surface #4
4. +1/2” 90% Argon / 10% Air
5. +1/4” Low Iron Heat Strengthened Glass
6. +0.06” PVB
7. +1/4” Low Iron Heat Strengthened Glass

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.
2.

a)
b)
1)
2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Provide metal supports and fastenings, gypsum board, and related accessories specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Qualifications of Installers: Use only skilled and experienced gypsum drywall installers. Fully supervise at all times helpers and apprentices used for drywall work with thoroughly skilled gypsum drywall installers.

B. Manufacturers' Recommendations: Manufacturers' recommended use of materials, fastenings, and methods of installation is basis for acceptance or rejection of drywall work where not specifically otherwise shown or detailed.

1.05 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.06 REFERENCE STANDARDS

A. ASTM E580, Suspension Systems in Areas Requiring Seismic Restraint.

B. ASTM C1396, "Gypsum Wallboard"

C. ASTM C840 Standard Specification for Application and Finishing of Gypsum Board

D. Gypsum Association publications:
   1. GA-214, "Recommended Levels of Gypsum Board Finish"
   2. GA-600, "Fire Resistance Design Manual".
   3. GA-800, "Materials Handling Manual".

1.07 FIRE RESISTANCE RATINGS AND IDENTIFICATION

A. Where gypsum drywall systems with fire resistance ratings are indicated or are required to comply with governing regulations, provide materials and installation methods identical to applicable assemblies which have been tested and listed by recognized authorities, including Underwriters Laboratories, Warnok-Hersey and Factory Mutual.

B. All joints in fire rated gypsum board construction are required to be taped and floated. This includes all joints in concealed and exposed partitions, ceilings and other applications where gypsum board is utilized as a fire barrier. All screws are to be floated over.
   1. Do not use self adhesive Tape at fire rated construction. Provide standard Tape and Drywall Mud.

C. All rated partitions are to extend to the underside of the roof or floor deck above and are to be sealed at the point of intersection with the deck in accordance with requirements of Section 07 8500, Firestopping.

1.08 PRODUCT HANDLING

A. Protection: Protect gypsum drywall materials before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary and at Contractor's expense.

PART 2 - PRODUCTS

2.01 GYPSUM MATERIALS

A. Manufacturers: Use products and materials by the following manufacturers:
   1. United States Gypsum
   2. National Gypsum Company
   3. Georgia-Pacific Company
   4. Temple-Inland, Inc.
   5. CertainTeed Gypsum

B. Gypsum Wallboard: Conform to ASTM C1396, have tapered edges and furnished in largest practical sheet size to minimize number of joints. Provide thickness indicated on Drawings.
   1. Fire Retardant Gypsum Board: Conform to U.L. Design Numbers listed on drawings for type and manufacturer.

C. Backerboard for Ceramic Tile:
   1. Provide 5/8 inch "Dens-Shield" by Georgia Pacific Company, Diamondback GlasRoc Tilebacker by CertainTeed., or approved equal. Furnish largest size sheets practical to minimize joints. Conform to manufacturer's instructions for installation given the conditions detailed on the drawings. Caulk all joints where backer board comes into contact with dissimilar material.

D. Cement Board for thin brick: Provide 5/8 inch (as required to flush-out with adjacent drywall construction) "Durock" cement board as manufactured by United States Gypsum Co., or approved equal. Furnish largest size sheets practical to minimize joints. Conform to manufacturer's instructions for installation of cement board given the conditions detailed on the drawings. Caulk all joints where backer board comes into contact with dissimilar material.
   1. Fasteners: Provide 1", Type S-12, bugle-head screws, corrosion resistant treated.
      a. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
      b. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

E. Mold Resistant Gypsum Board: Provide 5/8" USG - Mold Tough gypsum board, CertainTeed - M2Tech gypsum board, or approved equal complying with ASTM D3273, "Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
   1. To be used at Toilet Room walls (where there is no tile) and at the ceiling.
   2. Fire Retardant Type X where required.

F. Abuse Resistant Gypsum Board: Provide National Gypsum "Hi-Abuse XP", 5/8" thick with abrasion and mold resistant finish paper or equal product by Georgia Pacific or USG.
   1. Fire Retardant Type X where required.

2.02 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Exterior Gypsum Soffit Board: Paper.
   3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.03 WALL AND PARTITION FRAMING

A. Provide products by Steel Framing Industry Association Members in good standing (listing found at http://www.archtest.com/certification/SFIA_SteelFraming.aspx).

B. Provide type, size, gauge and physical properties as described by the manufacturers load and height tables and in accordance with the current local building code. All section properties shall be calculated in accordance with the AISI Specification for the Design of Cold-Formed Steel Structural Members (latest edition).

C. At all instances where radius steel stud and drywall construction is shown on drawings it is intended that the radius be smooth not faceted. Contractor is required to provide smooth face radius by whatever means necessary.

D. Runners: Match studs; type recommended by stud manufacturer for floor and ceiling support of studs, and for vertical abutment of drywall work at other work.

E. Install supplementary steel framing, blocking and bracing in the metal framing system wherever walls or partitions are indicated to support work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with the stud manufacturer's recommendations and industry standards in each case, considering the weight or loading resulting from the item supported.
   1. Screw attach blocking between studs for support of surface mounted items.
      a. Plumbing fixtures.
      b. Toilet partitions.
      c. Wall cabinets.
      d. Toilet accessories
      e. Hardware.
      f. Architectural woodwork.
      g. Grab bars.
      h. Handrails and railings.
      i. Signage.
      j. Other items requiring backing for attachment.

F. Deflection Track: Manufacturer’s single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads, as follows:
   1. Minimum Uncoated-Steel Thickness: Match stud thickness.
   2. Flange Width: Minimum 2”.

G. Vertical Deflection Clips: Manufacturer’s standard clips, capable of isolating wall stud from upward and downward vertical displacement of primary structure.

H. Drift Clips: Manufacturer’s standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure.

I. Fasteners: Provide nut, bolts, washers, screws, and other fasteners with corrosion-resistant plated finish.

J. Electrodes for Welding: Comply with AWS Code and as recommended by stud manufacturer.

K. Galvanizing Repair: Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A 780.

2.04 ACOUSTICAL INSULATION

A. Manufacturer: ROCKWOOL™ AFB evo™, www.rockwool.com, or equal by Owens-Corning (ThermaFiber SAFB)
   1. Non-combustible, lightweight, mineral wool batt insulation to, ASTM C665 Type 1, that provides fire resistance to ASTM E136 and sound control to ASTM C423.
   2. Fire performance:
      a. Non-combustibility: To ASTM E136.
      b. Surface Burning Characteristics: To ASTM E84.
         1) Flame spread: 0.
         2) Smoke developed: 0.
   3. Density: To ASTM C167, 2.5 lbs/ft3(thicknesses ≥ 3”), 2.8 lbs/ft3 (thicknesses < 3”)
   4. Acoustical Performance:
      a. Airborne sound transmission loss: To ASTM E90.
      b. Rating sound insulation: To ASTM E413.
      c. Impedence and absorption of acoustic materials: To ASTM E1050.
      d. Sound absorption co-efficients: To ASTM C423.

Sound Absorption Co-efficiences at Frequencies

Thickness (inches)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
1	0.14	0.25	0.65	0.90	1.01	1.01	0.70
1 1/2	0.18	0.44	0.94	1.04	1.02	1.03	0.85
2	0.28	0.60	1.09	1.09	1.05	1.07	0.95
3	0.52	0.96	1.18	1.07	1.05	1.05	1.05
4	0.86	1.11	1.20	1.07	1.08	1.07	1.10

2.05 DIRECT CEILING SUSPENSION SYSTEMS

A. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Armstrong World Industries, Inc.; Drywall Grid Systems.
      b. Chicago Metallic Corporation; Drywall Grid System.
      c. USG Corporation; Drywall Suspension System.

2.06 FASTENERS

A. Drywall Screws: Self-drilling type, 1" long for single layer application of gypsum board to metal studs and furring channels and of longer length for multiple layer installation.

B. Powder-Actuated Fasteners: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

2.07 ACCESSORIES

A. Corner Beads: 0.014 inch thick, hot dip galvanized steel with 1" flanges with 1/16" radius nose with large openings in flange similar to 5/8" diameter holes 7/8" on center.

B. Control and Expansion Joints: "Sheetrock" zinc control joint No.093 by USG, or approved equal. Provide safing and/or acoustical insulation behind control joints as required for adjacent partition construction. Use fire rated control joints in partitions requiring a fire rating.

2.08 ACCESS DOORS

A. Ceiling Access: Provide 24" x 24" Model FG glass fiber reinforced gypsum drywall access door as manufactured by Karp Associates, Inc., 1-800-888-4212 or approved equal. Door are to be flush mounted gypsum panels in a 5/8" thick frame.

B. Wall Access: Provide 24" x 24" Model KDW Flush Access Door as manufactured by Karp Associates, Inc., 1-800-888-4212 or approved equal.

PART 3 - EXECUTION

3.01 GENERAL PROVISIONS

A. Comply with specified requirements, manufacturer's instructions and recommendations, and referenced standards.

B. In cold weather, heat building to provide uniform temperature of 50 to 70 and provide ventilation to eliminate excess moisture.

C. Deliver materials to job in original unopened containers or bundles and store protected from damage and exposure to the elements.

D. Provide casing beads where edges of gypsum board meet dissimilar materials.

E. Cooperate with carpenters in placing of backing and blocking required for millwork, fixtures, fittings, and accessories.

F. Make cut-outs in panels for pipes, fixtures and small openings. Make holes and cut-outs by method that will not fracture wallboard core or tear covering. Cut holes with accuracy so plates, escutcheons and trim cover edges.

G. Seal cut edges, holes, and areas where wallboard covering is broken, with resistant sealer.

H. Install trim in strict accordance with manufacturers' recommendations. Install trim plumb, level, and true to line with firm attachment to supporting members.

I. At any change in direction of gypsum board, provide sufficient auxiliary framing, blocking or nailers to allow secure attachment along every edge of every individual piece of gypsum board. Do not leave any loose edges.

3.02 INSTALLATION OF METAL SUPPORT SYSTEMS

A. Do not bridge building expansion joints with support system, frame both sides of joints with furring and other support as indicated.

B. Ceiling Support Suspension System: Install in accordance with manufacturers recommendations.

C. Wall/Partition Support System
   1. Install supplementary framing, blocking and bracing to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported on gypsum board alone.
   2. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.
   3. Do not attach stud system to ductwork, piping, conduit, etc.
   4. Install runners (tracks) at floors, ceiling and structural walls and columns where gypsum drywall stud system abuts other work, except as otherwise indicated.
   5. Extend partition stud system through acoustical ceilings and elsewhere as indicated to the structural support and substrate above the ceiling as indicated. Install angle bracing at 4'0" on center from ceiling runner to structure above.
   6. Frame door openings with vertical studs securely attached by screws at each jamb either directly to frames or to jamb anchor slips on door frame; install runner track sections (for jack studs) at head and secure to jamb studs. Install angle bracing above ceiling to structural in each direction at strike side of door. Double studs at all door openings.
   7. Provide runner tracks of same gage as jamb studs. Space jack studs same as partition studs.
   8. Frame openings other than door openings in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads. Opening for ductwork, piping must allow clearance for insulation, dampers, etc.
   9. Install wall/partition support system to maximum tolerances of 1/8" in 12'-0" measured horizontally and vertically.
   10. At rated partitions, provide "5 sided" gypsum board enclosures where items (i.e. toilet accessories, electrical items, fire extinguisher cabinets, etc.) penetrate the surface of the wall, in order to maintain fire resistive integrity of the wall. Provide necessary related blocking.
       a. "5 sided" enclosures may be omitted where metal electrical backboxes not exceeding 16 square inches occur at one side only of a wall within a single stud cavity.

b. In this case, provide fire stopping material described in Section 07 8500 to completely encompass the back box and its annular space.

c. If 5 sided gypsum board enclosures are not to be provided at any fire rated partitions, all provisions for installation of electrical boxes in rated partitions as described by Underwriters Laboratories shall be adhered to AND prior approval shall be given in written form by the Architect.

11. Provide "5 sided" enclosures similar to those described above at all penetrations into "sound" partitions and insulated exterior walls regardless of size. The provisions for the omission of the 5 sided enclosures at certain fire rated partitions do not apply to these sound and exterior partitions.

3.03 GENERAL GYPSUM BOARD INSTALLATION REQUIREMENTS

A. Pre-Installation Conference: Meet at the project site with the installers of related work and review the coordination and sequencing of work to ensure that everything to be concealed by gypsum drywall has been accomplished, and that chases, access panels, openings, supplementary framing and blocking and similar provisions have been completed.

B. Install sound attenuation blankets where indicated, prior to gypsum board unless readily installed after board has been installed.

C. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 1'-0" in alternate course of board.

D. Install ceiling boards in the direction and manner which will minimize the number of end-butt joints, and which will avoid end joints in the central area of each ceiling. Stagger end joints at least 1'-0".

E. Install wall/partition boards vertically to avoid end-butt joints wherever possible. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs. Do not butt boards to concrete floor. Maintain a minimum 1/4" to a maximum 3/8" space between bottom of board and concrete.

F. Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16 inch open space between boards. Do not force into place.

G. Locate either edge or end joints over supports, except in horizontal applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Position boards so that like edges abut, tapered edges against tapered edges and mill-cut or field-cut ends against mill-cut or field cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.

H. Attach gypsum board to framing and blocking as required for additional support at openings and cutouts. Space between recessed boxes and cut edges shall not exceed 1/8 inches.

I. Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories described below in article entitled "INSTALLATION OF DRYWALL TRIM ACCESSORIES".

J. Cover both faces of partition framing with gypsum board in concealed spaces (above ceilings, etc.) except in chase wall which are braced internally.

K. Space fasteners in gypsum boards in accordance with referenced standards and manufacturer's recommendations, except as otherwise indicated.

3.04 INSTALLATION OF CEILING ACCESS PANELS

A. General Contractor is required to coordinate locations and number of access panels with affected trades in order to minimize the number of access panels required.

B. Provide ceiling access panels in gypsum board ceilings as specified. Provide quantity required for access to the following items commonly found above the ceiling plain:
   1. Operable portion of fire, smoke and other dampers
   2. Valves and other operable portions of sprinkler system
   3. Valves to mechanical, domestic and other piping systems
   4. Mechanical devices
   5. Fire alarm devices
   6. Communication system devices and connection points
   7. Sanitary and storm sewer clean outs
   8. Also included are any other items located above an otherwise inaccessible ceiling that will require adjustment, maintenance, inspection, connection or replacement in whole or in part at any time after the initial installation of the item or the ceiling.

3.05 METHODS OF GYPSUM BOARD APPLICATION

A. On ceilings:
   1. Apply gypsum board prior to wall/partition board application to the greatest extend possible. For single-ply construction, use perpendicular application. For two-ply assembles use perpendicular application and apply face ply of gypsum board so that joints of face ply do not occur at joints of base ply with joints over framing members.
   2. Where screws are used, they shall be spaced not more than 12 in. o.c. for ceilings where the framing members are 16 in. o.c.
   3. Screws shall be spaced not more than 12 in. o.c. for ceilings where framing members are 24 in. o.c.
   4. For applications on wood or other applications, refer to Gypsum Association GA-216 for fastener type and spacing.

B. On partitions except shaft wall:
   1. Use maximum length sheets practical to minimize end joints.
   2. When gypsum board is installed parallel to framing members, space fasteners 12 inches on center in field of the board, and 8 inches on center along edges.
   3. For applications on wood or other applications, refer to Gypsum Association GA-216 for fastener type and spacing.

4. When gypsum board is installed perpendicular to framing members, space fasteners 12 inches (304.8mm) on center in field and along edges.
5. Stagger screws on abutting edges or ends.
6. For single-ply construction, apply gypsum board with long dimension either parallel or perpendicular to framing members as required to minimize number of joints.
7. For two-ply gypsum board assemblies, apply base ply of gypsum board to assure minimum number of joints in face layer. Apply face ply of wallboard to base ply so that joints of face ply do not occur at joints of base ply with joints over framing members.

C. Wall Tile Base: Where drywall is base for thin set ceramic tile and similar rigid applied wall finishes, install gypsum backing board. At "wet" areas, install with un-cut long edge at bottom of work, and space 1/4" above fixture lips. Seal ends, cut-edges and penetrations of each piece with water resistant compound before installation.

3.06 INSTALLATION OF DRYWALL TRIM ACCESSORIES

A. General: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges to comply with manufacturer's recommendations.

B. Install metal corner beads at external corners of drywall work. Corner beads are to be completely bedded and taped.

C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed, and except where plastic trim is indicated. Provide type with face flange to receive joint compound except where semi-finishing type is indicated. Install L-type trim where work is tightly abutted to other work, and install special kerf-type where other work is kerfed to receive long leg of L-type trim. Install U-type trim where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints).

D. Install metal control joints where indicated on drawings. If not indicated on drawings, install in accordance with the following:
1. Interior Partitions: Maximum Single Dimension not to exceed 20 feet. Maximum Single Area not to exceed 400 Sq. Ft.
2. Interior Ceiling With Perimeter Relief: Maximum Single Dimension not to exceed 40 feet. Maximum Single Area not to exceed 1,600 Sq.Ft. Install control joint at any change of direction of ceiling framing or support system.
3. Interior Ceiling Without Perimeter Relief: Maximum Single Dimension not to exceed 20 feet. Maximum Single Area not to exceed 400 Sq.Ft. Install control joint at any change of direction of ceiling framing or support system.

3.07 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   2. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   4. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   6. Do not attach hangers to steel roof deck.
   7. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   8. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   9. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.08 JOINT TREATMENT AND FINISHING

A. General: Joint treatment for gypsum board surfaces is also described in Section 09 9000.

B. All joints in gypsum board construction are to be taped and floated. This includes work above ceilings, at concealed places and anywhere else joints in gypsum board construction occur.
   1. All screw and/or nail heads are to be floated smooth both above and below ceiling line.

C. Finish Levels:
   1. Level 1: At Ceiling plenum areas and concealed areas.
   2. Level 2: At surfaces that are substrate for tile.
   3. Level 3: At surfaces receiving medium (Orange Peel) or heavy (Knock-Down) texture finishes before painting or heavy wall coverings where lighting conditions are not critical.
   4. Level 4: In back-of-house areas, finish gypsum wallboard in accordance with ASTM C840, Level 4
   5. Level 5: In all areas exposed to public or tenant view, finish gypsum wallboard in accordance with ASTM C840, Level 5.

3.09 CLEANING UP

A. Do not allow accumulation of scraps and debris arising from work of this Section. Maintain premises in neat and orderly condition at all times. Immediately remove spilled or splashed compound material and all trace of residue from adjoining surfaces.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Definition: Drywall shaft systems include special-purpose assemblies of gypsum boards and metal components designed for erection entirely from one side of shaft.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Industry Standard: Comply with applicable requirements of GA-216 "Application and Finishing of Gypsum Board" by the Gypsum Association, except where more detailed or more stringent requirements are indicated including the recommendations of the manufacturer.

B. Allowable Tolerances: On faces of work exposed in occupied spaces, including stairwells (if any), limit offsets between planes of board faces to 1/8", and limit variation from plumb and location (including warp and bow) to 1/4" in 8'-0".

C. Fire Resistance Ratings: Provide drywall shaft systems which have fire resistance ratings indicated or required to comply with governing regulations, and which are identical in construction in forms of materials and installations to assemblies which have been tested and listed by recognized authorities, including UL.
   1. Comply with FM "Approval Guide" when applicable.
   2. Fire Resistance Rating as indicated on drawings.

D. Corridor partitions, smokestop partitions, horizontal exit partitions, exit enclosures, and fire walls shall be effectively and permanently identified with signs or stenciling in a manner acceptable to the authority having jurisdiction. Such identification shall be above any decorative ceiling and in concealed spaces. Suggested wording shall be approved by the authority having jurisdiction.

E. System Design Loading: Provide drywall shaft systems designed and tested by manufacturer to withstand the following lateral loadings (air pressures), applied continuously and cyclically, for maximum heights of partitions required, within the following deflections limits.
   1. Lateral Loading: As indicated but not less than 10 psf.
   2. Deflection Limit: As indicated but not less than 1/240 of partition height.

F. Sound Transmission Class: Provide drywall shaft systems designed and tested by manufacturer to achieve the following (minimum) STC rating (ASTM E 90).
   1. Rating: As indicated but not less than 35 STC.

1.05 PRODUCT HANDLING

A. Deliver drywall shaft system components and materials in sealed containers and bundles, fully identified with manufacturer's name, brand, type and grade; store in a dry, well ventilated space, protected from the weather, under cover and off the ground.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide drywall shaft system components produced by a single manufacturer selected from the following list:
   1. United States Gypsum
   2. National Gypsum Company
   3. Georgia-Pacific Company
   4. Temple-Inland, Inc.

2.02 BASIC SYSTEM MATERIALS

A. General: Except as otherwise indicated or required by governing regulations, provide the manufacturer's standard materials specified in his published product literature for the system and application required.

B. Metal Framing and Furring:
   1. Provide products by Steel Framing Industry Association Members in good standing (listing found at http://www.archtest.com/certification/SFIA_SteelFraming.aspx).
   2. Hot-dip galvanized steel, ASTM A 446, G 90 coating; except comply with ASTM C 645 for 25-gage members, provide electro-galvanized or hot-dip galvanized coating.

C. Gypsum Shaftwall Board: Manufacturer's special gypsum backing board or coreboard, of thickness and type indicated and as required to comply with system performance requirements.

D. Exposed Gypsum Board: ASTM C 36, Type X where required for fire-resistance rating. Long Edge Profile: Standard taper.

E. Drywall Trim Accessories: Provide manufacturer's standard trim accessories of types indicated for drywall work, formed of galvanized steel, with either knurled and perforated or expanded flanges for nailing or stapling, and beaded for concealment of flanges in joint compound. Provide corner beads, L-type edge trim-beads, U-type edge trim-beads, special L-kerf-type edge trim-beads, and one-piece control joint beads.

F. Joint Treatment Materials: ASTM C 475; type recommended by the manufacturer for the application indicated, except as otherwise indicated.
1. Joint Tape: Perforated type.
2. Joint Compound: Ready-mixed vinyl-type for interior use.
3. Grade: 2 separate grades; one specifically for bedding tapes and filling depressions, and one for topping and sanding.
4. Joint Compound: On interior work provide chemical-hardening- type for bedding and filling, ready-mixed vinyl-type or vinyl-type powder for topping.

G. Miscellaneous Materials: Provide auxiliary materials for gypsum drywall work of the type and grade recommended by the manufacturer of the system.
1. Laminating Adhesive: Special adhesive or joint compound specifically recommended for laminating gypsum boards.
2. Gypsum Board Fasteners: Comply with GA-216.

2.03 BASIC SYSTEM DESCRIPTION

A. General Requirements: The following descriptions indicate type of manufacturer's standard systems required; the descriptions are not intended to be comprehensive but to identify a discrete type of system. Provide a complete system, complying with requirements indicated. Modify and supplement manufacturer's standard system to comply with performance requirements, including those of governing regulations. Provide the depth, profile, gage, and anchorage system of metal support members recommended by manufacturer for heights and system design loading criteria indicated; provide runners, stiffeners, braces, and similar framing members required to form a complete system.

B. Cavity Shaftwall Systems: Provide shaftwall assemblies consisting of gypsum shaftwall boards inserted between U-shaped metal floor and ceiling tracks; specially-shaped studs engaged in tracks and fitted between shaftwall boards; and gypsum boards on finished side or sides applied to studs in number of layers, thicknesses and arrangement indicated.
1. Shaftwall Board Thickness: Not less than 1".
2. Stud Shape: I, C-H or double E.
3. Stud Size: As indicated.
4. Room-Side Finish: As indicated on drawings.
5. Shaft-Side Finish: As indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION OF DRYWALL SHAFT SYSTEMS

A. Preparations and Coordination
1. Pre-Installation Conference: Prior to the start of shaft system installation, meet at

the project site with the installers of related work including work requiring openings, chases, frames, access panels, support and similar integrated requirements including interference and conflicts, and coordinate layout and sequencing requirements for proper integration of the work.

2. Weather Exposure: Do not proceed with the installation of gypsum board until building is sufficiently enclosed and ambient conditions are adequately controlled to prevent moisture and weather deterioration of the work.

B. Installation of Basic System Components

1. General: Comply with the manufacturer's installation instructions. Comply with recognized industry standards for the installation of both lightgage metal framing and gypsum board, to the extent not specified by manufacturer's instructions. Anchor and fasten materials and components to comply with ratings and performance requirements, and to comply with governing regulations.
2. Do not bridge building expansion joints with drywall shaft system, frame both sides of joints with furring and other support as indicated.
3. Install supplementary framing, blocking and bracing to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported directly on gypsum drywall shaft system.
4. Isolate shaft system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Comply with details shown and with manufacturer's instructions.
5. Seal perimeter of each section of drywall shaft work where it abuts other work. Install a second bead of acoustical sealant in a location and manner which will prevent dislocation by air pressure differential between shaft and external spaces. Seal joints and penetrations in the work; comply with manufacturer's instructions.

C. Installation of Drywall Trim Accessories

1. General: Install metal trim accessories where room-side of drywall shaft system is indicated to receive drywall finish (tape and joint compound treatment), including spaces indicated for paint or wall coverings. Nail or staple the flanges of accessories in accordance with manufacturers instructions, and fasten integrally with gypsum board where possible. Apply trim wherever edge of gypsum board would otherwise be exposed or semi-exposed, including terminations of the work, openings in the work, external corners, expansion and control joints and similar edges, both exposed and abutting other work. Miter-cut corners of exposed trim accessories, and spline-reinforce from behind to eliminate offsets and misalignments.
2. Install L-type trim where board edges abut other work without space or reveal.
3. Install U-type trim where board edges are indicated for sealant or gasket application, or would otherwise be exposed (special kerf-type where kerf is provided to receive trim).
4. Install J-type semi-finishing trim where shown.
5. Install control-joint trim (beaded type) where indicated.

3.02 INSTALLATION OF DRYWALL FINISHING

A. Where room-side of drywall shaft work is indicated to receive drywall finish, including spaces indicated for paint or wall coverings, provide exposed boards with tapered edges and recessed fastener heads, ready for drywall finishing. Otherwise, for unfinished work, edge profile of exposed boards is Installer's option, except comply with requirements for fire-resistance and STC ratings.

B. Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fasteners heads, surface defects and elsewhere as required to prepare work for decoration. Prefill open joints and rounded or beveled edges, using type of compound recommended by manufacturer.
   1. Apply joint tape at joints between gypsum boards, except where a trim accessory is indicated.
   2. Apply joint compound in 3 coats (not including prefill of opening in base), and sand between last 2 coats and after last coat.
   3. Refer to sections on painting, coatings and wall-coverings in Division 9 for decorative finishes to be applied to drywall work.

3.03 PROTECTION OF WORK

A. Installer shall advise Contractor of required procedures for protecting drywall work from damage and deterioration during remainder of construction period.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish and install tile specified on walls shown.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Obtain each color, grade, finish, type, composition, and variety of tile from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

B. Obtain ingredients of a uniform quality from one manufacturer for each cementitious and admixture component and from one source or producer for each aggregate.

C. Engage an experienced Installer who has successfully completed tile installations similar in material, design, and extent to that indicated for Project.

D. Install ceramic tile in accordance with recommendations contained in "Handbook for Ceramic Tile Installation" of the Tile Council of America, Inc., latest edition.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If despite these precautions coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.06 PROJECT CONDITIONS

A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

C. Maintain temperatures at 50 F (10 C) or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.07 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials that match products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed but a minimum of 12 pieces, for each type, composition, color, pattern, and size.

PART 2 - PRODUCTS

2.01 PRODUCTS, GENERAL

A. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1 "American National Standard Specifications for Ceramic Tile" for types, compositions, and grades of tile indicated. Furnish tile complying with "Standard Grade" requirements unless otherwise indicated.

B. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.

C. Conform to ADA requirements for slip resistance by providing minimum coefficients of sliding friction of 0.6 COF for horizontal surfaces and 0.8 COF for ramps and other sloped surfaces.

D. Factory blending: For tile exhibiting color variations within the ranges selected during sample submittals, blend tile in factory and package accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.

2.03 TILE PRODUCTS

A. WT-01: Wall Tile, Type 1 (Subject to change)
Manufacturer: Platform Surfaces
Pattern/Color: Rustica Pevero
Size: 2” x 16”
Installation: Vertical Stack
Grout Joint: minimum recommended by manufacturer
Grout: Custom Tile Installation Systems Color TBD
Notes: Refer to Finish Plans for layout

B. WT-02: Wall Tile, Type 2 (Subject to change)
Manufacturer: Platform Surfaces
Pattern/Color: Rustica Mugoni
Size: 2” x 16”
Installation: Vertical Stack
Grout Joint: minimum recommended by manufacturer
Grout: Custom Tile Installation Systems, Color TBD
Notes: Refer to Finish Plans for layout

C. WT-03: Wall Tile, Type 3
Manufacturer: Spec Ceramic
Pattern/Color: Maiolica, Blue Steel Crackled
Size: 3” x 12” x 7.3mm
Installation: Horizontal Stack
Grout Joint: minimum recommended by manufacturer
Grout: Custom Tile Installation Systems 542 Driftwood
Notes: Refer to Finish Plans for layout

D. WTB-01: Wall Tile Base, Type 1
Manufacturer: Spec Ceramic
Pattern/Color: Maiolica, Blue Steel Crackled
Size: 3” x 12” x 7.3mm
Installation: Horizontal Stack
Grout Joint: minimum recommended by manufacturer
Grout: Custom Tile Installation Systems 542 Driftwood
Accessories:
Exposed edges of all tile types to receive Schluter Jolly, Black

2.04 SETTING MATERIALS

A. Thin-Set Applications at Walls (TCA W243): Latex-Portland Cement Mortar: ANSI A118.4, composition as follows: Prepackaged dry mortar mix composed of portland cement, graded aggregate, and the manufacturer's standard dry polymer additive in the form of a re-emulsifiable powder to which only water is added at job site.

2.05 GROUTING MATERIALS

A. Provide products to suit specific project requirements in accordance with TCA Handbook and as follows.
   1. Epoxy Grout: ANSI A118.3. Laticrete SpectraLOCK PRO, Ardex WA, or approved equal. Grout color to be selected from manufacturer's complete color line.

2.05 MISCELLANEOUS MATERIALS

A. Metal Edge Strips: Schluter "SCHIENE" single or multiple spacer design as required in satin anodized aluminum.

B. Provide other materials, not specifically described but required for complete and proper tile installation, selected by Contractor subject to approval of Architect.

C. Expansion Joints: In accordance with TCA Method EJ171.

D. Sealant: ASTM C920; TEC 155, AccuColor 100, or Ardex SX 100% Silicone

2.06 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and areas where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compounds.
   2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Blending: For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in factory and packaged accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 INSTALLATION, GENERAL

A. ANSI Tile Installation Standard: Comply with parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile" that apply to type of setting and grouting materials and methods indicated.

B. TCA Installation Guidelines: TCA "Handbook for Ceramic Tile Installation"; comply with TCA installation methods indicated.

C. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions except as otherwise shown. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.

E. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths unless otherwise shown.

F. Lay out tile wainscots to next full tile beyond dimensions indicated.

G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw cut joints after installation of tiles.
   1. Locate joints in tile surfaces directly above joints in concrete substrates.
   2. Provide expansion and control joints at not more than 15 feet o.c., at all expansion and control joints in the concrete subfloor and where otherwise recommended by the "Handbook for Ceramic Tile Installation" of the Tile Council of America.
   3. Movement joints shall be provided throughout the tile and work will conform to ANSI Specification A108.01-3.7; A108.02 B 4.4.and TCA Details EJ171.
   4. Seal all joints in accordance with requirements of Section 07 9000.

H. Grout tile to comply with the requirements of the following installation standards:
   1. ANSI A108.

3.04 INSTALLATION METHODS

A. Conform to TCA Handbook for installation on various substrates shown on drawings, using materials listed in Part 2 of this Specification Section.

B. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

3.05 CLEANING AND PROTECTION

A. Cleaning: Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove grout residue from tile as soon as possible.
   2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.

C. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensures that tile is without damage or deterioration at time of Substantial Completion.
   1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
   2. Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish and install suspension systems, ceiling boards, panels and tiles, and accessories required for complete installation of acoustical ceilings specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 APPLICABLE STANDARDS

A. American Society for Testing and Materials:
1. ASTM C 635, "Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings".
2. ASTM C 636, "Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels".
3. ASTM E 84, "Surface Burning Characteristics of Building Materials".
4. ASTM E 580, "Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint"
5. International Building Code, Section 16, Suspended Ceilings (Seismic Restraint)

1.05 SEISMIC RESTRAINT REQUIREMENTS

A. Based upon seismic design analysis described in IBC. Refer to Code Data for Seismic Category.

B. Category A or B: Ceiling installation should conform to basic minimums established in ASTM C636.

1.06 PRODUCT HANDLING

A. Protection: Protect suspended acoustical ceiling materials before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary and at Contractor's expense.

1.07 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials, totaling 3% of the total installed, matching products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.01 SUSPENSION SYSTEMS

A. Provide steel capped, 15/16" "Prelude" exposed tee grid by Armstrong World Industries, USG Interiors or Celotex.

B. Suspension Members: Intermediate or heavy duty type of sufficient strength and rigidity to carry acoustical ceiling units in true and level plane without exceeding 1/32" deflection in any 2 feet of their spans.

C. Fabrication: Fabricate suspension system components from cold-rolled sheet steel conforming to ASTM A 366. Protect from rust and corrosion with hot dipped galvanized coating.

2.02 ACOUSTICAL CEILING BOARDS

A. C3: Acoustical Ceiling Tile
Manufacturer: Armstrong
Product: Ultima Lay-In
Color: White (WH)
Panel Size: 24” x 24”
Thickness: ¾”
Edge: Square Lay-In 15/16

B. C4: Acoustical Ceiling Tile
Manufacturer: Armstrong
Product: Kitchen Zone
Color: White (WH)
Panel Size: 24” x 24”
Thickness: ¾”
Edge: Square Lay-In 15/16

C. BF-01: Ceiling Baffles
Manufacturer: Turf Design
Product: Slab
Color: Walnut D07 Dark
Size: 12”H x 119”W x 2 ¼”Thk
Installation: FeltLock to Unistrut

2.03 ACCESSORIES

A. Channel Trim Profiles: Provide Axiom "Vector" Components by Armstrong, or approved equal as follows:
   1. 2", 4", 6" and 8" Axiom Channel Profile.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Examine surfaces and conditions affecting proper installation of acoustical materials. Do not proceed until unsatisfactory conditions are corrected.

B. Do not start acoustical ceiling work until glazing is completed and exterior openings are enclosed.

C. All wet work, including concrete and masonry work must be completed and dried out before work is started.

D. Do not install acoustical materials unless uniform temperature in spaces where acoustical tile work is performed is at least 60E F. during and after installation.

E. Install acoustical ceilings, complete, including component parts necessary to suspend systems from structure.

F. Install suspension systems to permit border units of greatest possible size where not full size.

G. Following installation, clean soiled and discolored surfaces. Remove and replace units damaged or improperly installed.

H. For any units that do not have square edges and must be cut for any reason, install edge angle or "T" at same elevation as other supporting members and make a field cut in the same profile as the factory edge or splice in a factory edge. Paint cut edges or splice joints to match giving a visually flawless result.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish and install base specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver base and installation accessories to Project site in original manufacturer's unopened cartons and containers each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.

B. Store in dry spaces protected from the weather with ambient temperatures maintained between 50 deg F (10 deg C) and 90 deg F (32 deg C).

C. Store materials on flat surfaces. Move base and installation accessories into spaces where they will be installed at least 48 hours in advance of installation.

1.05 PROJECT CONDITIONS

A. Maintain a minimum temperature of 70 deg F (21 deg C) in spaces for at least 48 hours prior to installation, during installation, and for not less than 48 hours after installation. After this period, maintain a temperature of not less than 55 deg F (13 deg C).

B. Do not install base until it is at the same temperature as the space where it is to be installed.

C. Close spaces to traffic during installation.

1.06 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials, totaling 3% of the total installed, matching products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.01 RUBBER BASE

A. RB-01: Rubber Base
Manufacturer: Johnsonite
Profile: Monument 4” MW-__-S4
Color: TBD

2.02 INSTALLATION ACCESSORIES

A. Adhesives (Cements): Water-resistant type recommended by manufacturer to suit products and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas where installation will occur, with Installer present, to verify that substrates and conditions are satisfactory for installation and comply with manufacturer's requirements and those specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 4 inches in length.
    a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 4 inches in length.
   a. Miter or cope corners to minimize open joints.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to work of this Section.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUMMARY

A. This Section includes the following:
   1. Seamless resinous flooring.
   2. Wall base.

1.04 QUALITY ASSURANCE

A. All materials must be recommended and manufactured by a single supplier to insure compatibility and proper chemical and mechanical bond.

B. Surfacing shall be applied by a surfacing applicator approved by the Architect, with a minimum of seven (7) years experience installing the brand of surfacing in similar size and function projects. A list of ten (10) completed projects using the specified materials must be submitted proving seven (7) years experience by the lead mechanic.

C. Surfacing applicator shall provide to the architect a completed list of jobs including the names of the Architect, General Contractor, Owner, telephone numbers of all concerned, materials used, quantity installed and date completed on similar projects.

D. Surfacing applicator must provide a written joint guarantee for materials and workmanship between applicator and surfacing manufacturer for one (1) year.

E. Surfacing applicator or manufacturer seeking approval of products other than what is specified must supply samples, full product information, technical data with specifications, certification from an independent testing laboratory that the product being submitted for approval meets all requirements of the performance properties specified within this specification, installation instructions and comply with the above quality assurances in writing fourteen (14) days before bid letting. Omission of any item will result in an automatic rejection.

F. Bidders will be notified by addendum of substitute surfacing materials, if approved.

1.05 SUBMITTALS

A. Surfacing applicator shall submit samples of color and textures for Architect's approval.

B. Prior to commencing work, at architect's discretion, applicator shall install a 100 square foot sample on the job of desired color and texture and when approved, this will serve as the standard for the entire project.

1.06 PRODUCT STORAGE AND ENVIRONMENTAL CONDITIONS

A. Material temperatures shall be a minimum of 55ºF before use.

B. Work on seamless flooring shall not commence until the building can be maintained at a minimum temperature of 55ºF for 48 hours before, during and 48 hours after application. Areas shall also be broom clean and reasonably dust free and shall have adequately controlled ventilation with bright, uniform lighting.

1.07 PROJECT CONDITIONS

A. Before commencing work, ensure environmental and site conditions are suitable for application and curing.

B. Surfaces shall be acceptable in accordance with flooring manufacturer's recommendations.

C. Notify Architect and Contractor in writing of unsuitable surfaces and conditions. Commencement of work shall imply acceptance of surfaces and working conditions.

D. Recommended Moisture Vapor Transmission Considerations:
   1. Placement of on-grade slabs over a Class A vapor retarder as defined by ASTM E-145.
   2. A water cement ratio of 0.45 and 0.5.
   3. Curing by ASTM C-171 sheet materials for curing concrete.
   4. A slump in the range of 3 to 4 inches which can be increased by the use of super plasticizers.

E. Substrate requirements (See Appendix A).

1.08 PROTECTION

A. Protect adjacent surfaces from damage resulting from work of this trade. If necessary, mask and/or cover adjacent surfaces, fixtures, cabinet work, equipment, etc. by suitable means.

1.09 WARRANTY

A. Warranty – Applicator shall notify manufacturer of project requirements before bidding. Manufacturer shall provide single source warranty for entire installation including labor for two years. Warranty shall include removal and replacement if proven defective. Defective items are, but not limited to, debonding, discoloration, excessive wear and staining by bodily fluids.

PART 2 - PRODUCTS

2.01 RESINOUS FLOORING

A. Stonhard, Inc.; Stonclad GS®. With top coat Stonkote GS4.

B. System Characteristics:

PE-01: Poured Epoxy Floor
Manufacturer: StonHard
Product: Stonclad GS
Color: Charcoal (subject to change)

PEB-01: Integral Poured Epoxy Base
Manufacturer: StonHard
Pattern: Stonclad GS
Color: Charcoal (subject to change)
Height: 6" unless otherwise noted

C. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Primer:
   a. Material Basis: Stonhard Standard Primer
   b. Resin: Epoxy
   c. Formulation Description: (2) two component, 100 percent solids.
   d. Application Method: Squeegee and roller.
   e. Number of Coats: (1) one.
2. Mortar Base:
   a. Material design basis: Stonclad GS
   b. Resin: Epoxy.
   c. Formulation Description: (3) three component, 100 percent solids.
   d. Application Method: Metal Trowel.
      1) Thickness of Coats: nominal 1/4 inch (6.4 mm).
      2) Number of Coats: One.
   e. Aggregates: Pigmented Blended aggregate.
3. Top Coat:
   a. Material design basis: Stonkote GS4
   b. Resin: Epoxy.
   c. Formulation Description: (2) two component 100 percent solids.
   d. Type: pigmented.
   e. Finish: standard.
   f. Number of Coats: one.

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength: 10,000 psi after 7 days per ASTM C 579.
2. Tensile Strength: 1,750 psi per ASTM C 307.
3. Flexural Strength: 4,000 psi per ASTM C 580.
4. Water Absorption: < 1% per ASTM C 413.
5. Impact Resistance: > 160 in. lbs. per ASTM D 2794.
6. Flammability: Class 1 per ASTM E-648.
7. Hardness: .85 to .90, Shore D per ASTM D 2240.
8. Flexural Modulus of Elasticity: 2.0×10^6 psi per ASTM C-580

9. Thermal Coefficient of Linear Expansion: $1.4x10^{-5}$ in./in.˚F per ASTM C-531

2.02 ACCESSORY MATERIALS

A. Patching, Leveling and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for Stonflex MP7 joint fill material.

PART 3 - EXECUTION

2.01 FLOORING PREPARATION

A. Surface must be clean, sound and dry.

B. Effectively remove concrete laitance on accessible floor surfaces by mechanical shot blast. Acid etching is not acceptable.

C. Areas where flooring is existing must be cleaned to remove all floor material, grease or any residue that might retard interfacial adhesion between substrate and surfacing.

2.02 FLOORING APPLICATION

A. Apply flooring in accordance with manufacturer's printed instructions, employing lead mechanic qualified under the quality assurance portion of this specification, using equipment specifically designed for this purpose.

B. Apply surfacing at an approximate thickness of _1/8__". "Thickness can be varied from 30 mils to 3/16". Surfacing shall be tightly compacted, trowel and roller applied.

C. Install integral cove base.
1. Trowel apply vertical cove base.
2. Hand sand cove base.
3. Apply three coats of resin to assure a smooth surface and cove.
4. Do not allow resin to puddle in cove.

D. Install flexible membrane Desco 570 to a wet mil thickness of 20 mills.

E. Finished work shall match approved samples; be uniform in thickness, sheen, color, pattern, and texture; and be free from defects detrimental to performance.

2.03 PROTECTION

A. After completion of flooring the General Contractor/Owner shall protect flooring from damage by other trades.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. General: Furnish and install wall covering specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Qualifications of Installers:
   1. For cutting and installation of vinyl wall covering, use only thoroughly trained and experienced installers completely familiar with manufacturer's installation recommendations and completely familiar with requirements of this work.
   2. In acceptance or rejection of installed wall covering, no allowance made for lack of skill on part of installers.

B. Manufacturer's Recommendations: Wall covering manufacturer's recommendations is basis for installation methods used in this work.

1.05 PROJECT CONDITIONS

A. Maintain a constant temperature not less than 60ºF in installation areas for at least 10 days before and 10 days after installation.

1.06 PRODUCT HANDLING

A. Protection: Protect vinyl wall covering materials before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary at Contractor's expense.

PART 2 - PRODUCTS

2.01 WALL COVERING

A. WC-11: Wallcovering
Manufacturer: MDC Interior Solutions
Collection: Bolta Contract
Pattern: Soho
Color: Subway Slate BBHH04

B. WC-12: Cork Wallcovering
Manufacturer: Wolf Gordon
Material: Cork
Collection: Natural, NAT 4202
Pattern/Color: Trozos – TOFFEE

C. WC-13: Vinyl Graphic
Custom, Refer to Architectural Drawings

2.02 ADHESIVES

A. Manufacturer's standard for use with specific wall covering and substrate application.

B. Characteristics: Mildew-resistant, nonstaining, and strippable.

C. No wheat paste adhesives will be allowed.

D. DO NOT DILUTE ADHESIVE WITH WATER.

2.03 BRIDGING MATERIAL

A. Provide polyester fabric bridging material at areas where required to provide a smooth substrate for application of wall covering. Apply with manufacturer's recommended adhesive.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection:
1. Carefully inspect installed work of other trades and verify work is complete to point where this installation may properly commence.
2. Verify wall covering may be installed in accordance with manufacturer's recommendations.

B. Discrepancies: Do not proceed with installation in areas of discrepancy until discrepancies are fully resolved.

3.02 PREPARATION

A. Acclimatize wall covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

B. Follow manufacturer's printed instructions for surface preparation.
   1. Prepare substrates to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, and defects.
   2. Painted Surfaces: Treat areas susceptible to pigment bleeding.
   3. Metals: If not factory-primed, clean and apply rust inhibitive zinc primer.
   4. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
   5. Prime new gypsum board with a recommended primer.
   6. Wall Sizing: Size surfaces to receive wall covering with material recommended by wall covering manufacturer.

C. Check painted surfaces for pigment bleeding. Sand gloss, semi-gloss, and eggshell finishes with fine sandpaper.

D. Install wall liner, with no gaps or overlaps, where required by wall covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall covering installation until wall liner has dried.

3.03 INSTALLATION

A. Follow manufacturer's printed instructions for installation.

B. Install wall covering with no gaps or overlaps.

C. Install seams vertical and plumb at least 6 inches from outside corners and 3 inches from inside corners. No horizontal seams.

D. Remove air bubbles, wrinkles, blisters, and other defects.

E. Trim edges for color uniformity, pattern match, and tight closure at seams and edges. Butt seams.

3.04 CLEANING

A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended by the wall covering manufacturer. Do not use carbon-tetrachloride, cleaning solvents, or cleaning agent not specifically recommended by wall covering manufacturer.

C. Replace strips that cannot be cleaned.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: 12 pt. Times New Roman or CG Times

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide one of the following spray-applied cellulose acoustical insulation **[ACS-01]**:

1. "CAFCO Cellu-Shield" (Isolatek International)
2. "K-13 Spray-On-System" (International Cellulose Corporation)
3. Or approved equal.

B. Color: Custom color as noted

C. Bond strength shall be greater than 150 psf per ASTM E 736.

D. Class 1 / Class A per ASTM E 84/ UL 723.

E. Non-corrosive per ASTM C 739.

F. Bond Deflection per ASTM E 759: 6" Deflection in 10' Span – No Spalling or Delamination.

G. R-Value to be 3.90 per inch per ASTM C 518.

H. Meet ASTM C 1149

I. Minimum Fiber Recycled Content to be 75%.

J. Contains no asbestos, fiberglass, other man-made mineral fibers, or added Urea-Formaldehyde Resin

K. Primer and adhesives as required by manufacturer's written instructions for installed substrate.

PART 3 - EXECUTION

3.01 12 PT ALL CAPS AND BOLD

A.

1.

2.

a)

b)

1)

2)

B.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide acoustical wall panels specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Furnish at least one person, present at all times, thoroughly familiar with installation requirements of each item, to personally supervise installation.

1.05 PRODUCT HANDLING

A. Protect wall panels before, during, and after installation. Protect installed work and materials of other trades.

B. In event of damage, immediately make repairs and replacements at Contractor's expense.

PART 2 - PRODUCTS

2.01 ACOUSTICAL WALL PANELS

A. WW-01: Wood Wool, Type 1
Manufacturer: Armstrong
Product: Tectum Finale Wall Panels
Size: 1” thick, refer to drawings for sizing
Color: Natural
“A” Mounting
NRC Minimum of .80

B. WW-02: Wood Wool, Type 2
Manufacturer: Armstrong
Product: Tectum Finale Wall Panels
Size: 1” thick, refer to drawings for sizing
Color: Painted to Match PT-02
“A” Mounting
NRC Minimum of .80

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Prior to installation, verify items may be installed in accordance with manufacturers' recommendations.
B. Notify Architect of conditions that would adversely affect installation.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall panels in strict accordance with manufacturers' current recommendations and instructions.

3.03 ADJUSTMENT AND CLEANING

A. Verify that trim is in place and adjust components.

B. Remove labels and packing materials from job site.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Provide specified painting and finishing of interior and exterior items.
   1. **Do not paint** over any code required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates. Mask off the label before applying finish and remove masking after finish is dry.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Product Data: For each type of product. Include preparation requirements and application instructions.

C. Color Samples: For each type of paint system and in each color and gloss of topcoat. This is required for final color verification. DO NOT proceed with paint application until all colors have received final approval.
   1. Submit Samples on rigid backing, 8 inches square minimum.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Substitutions will not be considered prior to the award of the General Contract.

1.04 DEFINITIONS

A. Term "paint", as used herein, includes enamels, paints, sealers, fillers, emulsions, varnishes, stains, and other coatings whether used as prime, intermediate, or finish coats.

1.05 QUALITY ASSURANCE

A. Qualifications of Painters: Use only qualified journeyman painters for mixing and application of paint. In acceptance or rejection of painting, no allowance made for lack of skill on part of painters.

1.06 PRODUCT HANDLING

A. Delivery: Deliver paint materials to job site in original unopened containers with labels intact and legible at time of use.

B. Protection:
   1. Store only approved materials at job site and store only in suitable and designated area restricted to storage of paint materials and related equipment.
   2. Ensure safe storage and use of paint materials and prompt and safe disposal of waste.
   3. Protect paint materials before, during, and after application and protect installed work and materials of other trades.

PART 2 - PRODUCTS

2.01 PAINT MATERIALS

A. Manufacturers: Provide paints, enamels, stains, varnishes, and admixtures of first line quality by Benjamin Moore to match paint systems specified.
   1. Sherwin Williams products specified herein establish minimum quality standards.

B. Compatibility:
   1. Paint materials and equipment to be compatible. Finish coats compatible with prime coats, prime coats compatible with surface to be coated, and tools and equipment compatible with coating applied.
   2. Thinners (when used): Use thinners recommended for that purpose by manufacturer of material thinned.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection: Carefully inspect installed work of other trades and verify work is complete to point where painting work may properly commence. Verify paint finishes may be applied in strict accordance with manufacturer's directions and requirements of these Specifications.

B. Discrepancies: Do not proceed with installation in areas of discrepancy until discrepancies are fully resolved.

3.02 PREPARATION OF SURFACES

A. Protection: Completely mask, remove, and adequately protect hardware, accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with painted surfaces not scheduled to receive paint.

B. Priming: Use primer recommended by manufacturer of coating system. Spot prime exposed nails and metals to be painted with emulsion paints.

C. Cleaning: Thoroughly clean surfaces receiving paint. Schedule cleaning and painting so dust and contaminants from cleaning process will not fall on wet, newly painted surfaces.

D. Gypsum Board: Treat and conceal joints, screwheads, and depressions in gypsum board surface in accordance with manufacturer's recommendations and instructions. Painted surfaces must be completely clean and continuously smooth. Treat internal and exterior corners and angles formed by intersection of wallboard surfaces and wallboard edges with joint reinforcements system in accordance with manufacturer's standard installation specifications where intersections and edges do not have metal trim. **All joints in gypsum board construction are to be taped and floated. This includes work above ceilings, at concealed places and anywhere else joints in gypsum board construction occur.** A slight egg-shell texture may be acceptable if approved by Architect prior to application. Heavy "knockdown" texturing is not acceptable.

E. Concrete and Concrete Block: Prepare surfaces in strict accordance with paint manufacturer's instructions and recommendations. Remove chalk, dust, dirt, grease, oils and substances which negatively effect paint adhesion. Perform appropriate tests to determine alkalinity and moisture content of surfaces. If surfaces are found sufficiently alkaline to cause blistering and burning of paint, correct condition before applying paint.

F. Primed Ferrous Metals (Typical): Clean ferrous metals free of dust, grease and grime. Sand smooth rust spots, marks and abrasions in surfaces. Touch-up shop-applied prime coats which have damage or bare areas. Wire-brush, solvent clean, and touch up with same primer as shop coat.

G. Galvanized Metal Surfaces: Clean free of oil and surface contaminates with acceptable non-petroleum based solvent. Touch up bare metal with zinc chromate primer.

H. Non-ferrous Metals: Clean off all oxidation, dust, grease and grime.

I. Area to Receive Wall Covering: Do not paint surfaces requiring wall covering finish.

3.03 WORKMANSHIP

A. Do not perform outside painting in extremely cold, frosty, or damp weather. Do not paint in dusty rooms. If required, sprinkle floors, to lay dust. Do not apply coats of paint on either wet or damp surfaces and in no case unless preceding coat is dry and hard.

B. Clean surfaces before priming. Remove dirt, oil, grease, rust, scale, and foreign matter. Clean with sandpaper, steel scraper, or wire brushes where necessary.

C. Specified coats are to cover completed painting and finishing work. Where color, stain, or undercoats show through final coat, install additional coats until uniform coverage is obtained.

D. Vary tints of undercoats slightly for identification of succeeding coats. Ample time of drying required to secure best possible results.

E. At all accent paint locations, contractor to mock-up approximately 3'-0" x 3'-0" color swatch, with final approval of color pending client walk-through.

F. Coats specified are in addition to shop or mill priming required under other Sections of these specifications.

G. All cabinet devices that require finish painting are to be painted with doors in the open position and shall be allowed to dry for a minimum of 24 hours in the open position. DO NOT PAINT DOORS CLOSED AND TRIM AFTER DRYING.

1. Cabinets that require finish painting include, but are not limited to, wall and ceiling access doors, fire extinguisher/hose/valve cabinets, electrical panel boxes, etc.

H. Corridor partitions, smokestop partitions, horizontal exit partitions, exit enclosures, and fire walls shall be effectively and permanently identified with signs or stenciling in a manner acceptable to the authority having jurisdiction. Label each wall at 20'-0" maximum. Such identification shall be above any decorative ceiling and in concealed spaces. Approved wording is to be:

FIRE AND SMOKE BARRIER - PROTECT ALL OPENINGS

3.04 PAINT SCHEDULE

A. Finish surfaces as follows:

	SURFACE	TREATMENT
1.	**Exterior Ferrous Metals:**	1st Coat - SW Pro-Cryl Universal Water Based Primer, B66-310 Series (Touch up only on primed surfaces) 2nd & 3rd Coats - SW Pro Industrial DTM Acrylic Coating B66-1250 Series
2.	**Egress Stair Railings and Handrails:**	1st Coat - Primer: SW Pro Industrial Water Based Epoxy (Pre-Catalyzed) 2nd & 3rd Coats - K46W00151 – SW Pro Industrial Pre-Catalyzed Waterbased Semi-Gloss Epoxy
3.	**Exterior Exposed Structural Steel Not Factory Galvanized:**	1st Coat – SW ZINC CLAD® 3100 Waterbased Pre-Construction Primer 2nd & 3rd Coats - SW Pro Industrial DTM Acrylic Coating B66-1250 Series
4.	**Interior Ferrous Metals:**	1st Coat - SW Pro-Cryl Universal Water Based Primer, B66-310 Series (Touch up only on primed surfaces) 2nd & 3rd Coats - SW Pro Industrial Acrylic, B66-600 Series.

5.	**Exterior Aluminum:**	Sherwin Williams, Fluropon Classic II **Perform surface prep and priming as required by manufacturer for both Shop Applied and Field Applied systems.**
6.	**Galvanized Metal:** (Includes exposed galvanized steel lintels, railings, stairs, doors and frames at interior and exterior locations)	1st Coat - SW Pro-Cryl Universal Water Based Primer, B66-310 Series (Touch up only on primed surfaces) 2nd & 3rd Coats - SW Pro Industrial Acrylic, B66-600 Series
7.	**Int. Gyp. Board - Painted:**	1st Coat - SW ProMar 200 Zero VOC Latex Primer, B28W2600 2nd & 3rd Coats - SW ProMar 200 Zero VOC Latex .
8.	**Int. Gyp. Board - Glazecoat:**	1st Coat - SW ProMar 200 Zero VOC Latex Primer, B28W2600 2nd & 3rd Coats - K46W00151 - Pro Industrial PreCatalyzed Waterbased Semi-Gloss Epoxy
9.	**Interior CMU - Painted:**	Prime Coats - SW PrepRite Block Filler, B25W25 as required to eliminate all pinholes. 2nd & 3rd Coats - SW ProMar 200 Zero VOC Latex .
10.	**Interior CMU - Glazecoat:**	Fill CMU walls with Three (3) Coats of Sherwin Williams Loxon Block Surfacer, LX01W200. 2nd & 3rd Coats: K46W00151 - Pro Industrial PreCatalyzed Waterbased Semi-Gloss Epoxy, K46-150 Series
11.	**Interior Exposed Structure and Exposed Overhead MEP:**	Prime Coat - Provide manufacturer's recommended primer, undercoat if required. 1st & 2nd Coats - SW Pro Industrial Waterborne Acrylic Dry Fall, B42 Series
12.	**Acoustical Fiber Panels (Tectum):**	Prime Coat - KILZ® ORIGINAL LOW ODOR Interior Primer or KILZ RESTORATION™ Interior Primer 1st & 2nd Coats - SW Pro Industrial Waterborne Acrylic Dryfall, B42 Series

B. Paint Color Schedule

~~PT-01: Paint, Type 1~~
~~Manufacturer: Benjamin Moore~~
~~Color: Black PM-9~~
~~Latex Paint~~
~~Finish: Matte~~

PT-02: Paint, Type 2
Manufacturer: Benjamin Moore
Color: Flint AF-560
Latex Paint
Finish: Matte

PT-03: Paint, Type 3
Shop applied Sherwin Williams, Steel Horizon, Fluropon Classic II

PT-04: Paint, Type 4
Field applied to match PT-03. Match architect's sample provided by precision coatings.
PC6 Waterborne Urethane
Color: Steel Horizon Metallic
Sheen: Satin

PT-05: Paint, Type 5
Manufacturer: Benjamin Moore
Color: Wire Frame Glasses 2132-20
Latex Paint
Finish: Flat

PT-06: Paint, Type 6
Manufacturer: Benjamin Moore
Color: Wire Frame Glasses 2132-20
Latex Paint
Finish: Semi-Gloss

PT-07: Paint, Type 7
Manufacturer: Benjamin Moore
Color: Neon Red 2087-10
Latex Paint
Finish: High Gloss
Location: Door frames and exposed plumbing

PT-08: Paint, Type 8
Manufacturer: Benjamin Moore
Color: Shark Gray 2134-40
Epoxy Paint
Finish: Eggshell

PT-09: Paint, Type 9
Manufacturer: Benjamin Moore
Color: Intense White OC-51
Latex Paint
Finish: Eggshell

PT-10: Paint, Type 10
Manufacturer: Benjamin Moore
Color: Intense White OC-51
Epoxy Paint
Finish: Eggshell

PT-11: Paint, Type 11
Manufacturer: Benjamin Moore
Color: Intense White OC-51
Latex Paint
Finish: Flat

PT-12: Paint, Type 12
Manufacturer: Benjamin Moore
Color: Black PM-9
Scuff-X
Finish: Semi-Gloss

3.05 PAINTING OF MECHANICAL AND ELECTRICAL WORK

A. Painting of pipe and duct insulation and uncoated ferrous metal in inaccessible pipe and duct chases, in plumbing chases, and in spaces above ceiling is not required.

B. Metal Work in Mechanical Room (finish as follows):
   1. Clean prefinished equipment and touch up with enamel to match manufacturer's final coat.
   2. Clean exposed pipe, exposed conduit and electric outlet boxes, hangers and brackets, valve handles, and miscellaneous pipe line devices and give two coats of medium gray enamel.
   3. Clean prime painted or unfinished items of manufactured mechanical and electrical equipment, then prime and finish with two coats of enamel to match other finished items of equipment.
   4. Finish remaining exposed metal items with two coats of light grey enamel.

C. Paint exposed interior metal work, including ferrous and non-ferrous piping, for heating ventilating, plumbing and electrical equipment, electric cabinets, ventilating grilles, metal access panels. Give exposed metal items one coat of enamel undercoater and one coat of enamel in addition to priming coat.

D. Give pipe and duct insulation exposed to view one coat glue size and two coats enamel.

E. Paint all mechanical, electrical and plumbing items that are visible through registers, grilles and diffusers with Flat Black-Out paint.

3.06 PROTECTION, CLEAN UP, AND TOUCH-UP

A. Protect all work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.

B. Upon completion, clean paint drops and smears from hardware, glass and other surfaces and items.

C. Before final inspection, touch-up or refinish painted surfaces which have become damaged or discolored.
   1. Perform touch-up work in a manner to produce solid even color and finish texture to match surrounding color and finish texture.
   2. Areas that receive touch-up work and do not match surrounding color or finish texture will be refinished at Contractors expense.

3.07 REPAINTING AND REFINISHING

A. Thoroughly clean existing surfaces in present building to be repainted and give one or more new coats of same type of paint originally used. Clean existing natural finish surfaces, sand and give new coat of varnish or finish originally used. Treat patched and repaired surfaces as new surfaces. For bidding purposes figure two coats of paint as average requirement. Scrape surfaces to be repainted, sand by hand or machine, and prepare to receive new coats.

B. Paint rooms and areas in existing building noted on drawings to paint existing surfaces or required by Finish Schedule.

C. Paint all rooms and areas in existing building where cutting and patching occurs. Paint after cutting, patching, and remodeling in rooms and areas is completed. Where cutting and patching is required on only one wall or surface, paint the entire room or area. Where cutting or patching occurs along a corridor wall, paint entire corridor wall from corner to corner or between termination lines designated by Architect.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Furnish and install toilet partitions and urinal screens.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

C. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles and finishes.

D. Shop Drawings: Include plans, elevations, sections, details and attachments to other work.
   1. Show locations of cutouts for compartment-mounted toilet accessories.
   2. Show locations of reinforcements for compartment-mounted grab bars.

E. One Sample for Initial Selections: For each unit indicated.

1.04 QUALITY ASSURANCE

A. Use personnel skilled in work required, completely familiar with manufacturer's recommended methods of installation, and thoroughly familiar with requirements of this work.

1.05 PRODUCT HANDLING

A. Protection: Protect toilet partitions and other items under this Section before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary at Contractor's expense.

PART 2 - PRODUCTS

2.01 SOLID PLASTIC TOILET AND URINAL PARTITIONS

A. Provide Hiny Hiders floor mounted, overhead braced units as manufactured by Santana-Comtec. (Toilet partitions)
Provide Hiny Hiders wall mounted urinal partitions.

B. Doors, panels and pilasters shall be 1" thick constructed from High Density Polyethylene (HDPE) resins. Partitions shall be fabricated from polymer resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self-lubricating surface that resists marks from pens, pencils, markers and other writing instruments. All plastic components shall be covered with a protective plastic masking.

C. COMPONENTS
1. Doors and Dividing Panels: 55 inches high, mounted 14 inches above finished floor, with aluminum heat-sinc fastened to bottom edges.
2. Pilasters: 82 inches high, fastened to pilaster sleeves with stainless steel tamper resistant Torx head sex bolt.
3. Pilaster Sleeves: 3 inches high, 20 gage stainless steel, secured to pilaster with stainless steel tamper resistant Torx head sex bolt.
4. Mounting Brackets:
   a. At Partition to Wall Connections: Provide stainless steel continuous bracket. Type 304 stainless steel, No.4 satin finish, with stainless steel theft-resistant barrel nuts and machine screws of same material and finish.
   b. At Partition to Partition Connections: Provide manufacturer's standard "U" or "F" style. Type 304 stainless steel, No.4 satin finish, with stainless steel theft-resistant barrel nuts and machine screws of same material and finish.
5. Headrail: Heavy-duty extruded aluminum, anti-grip design, clear anodized finish, fastened to headrail bracket with stainless steel tamper resistant Torx head sex bolt and at top of pilaster with stainless steel tamper resistant Torx head screws.
6. Headrail Brackets: 20 gage stainless steel, satin finish, secured to wall with stainless steel tamper resistant Torx head screws.

E. HARDWARE
1. Hinges shall be 8" and fabricated from heavy-duty extruded aluminum (6463-T5 alloy) with bright dip anodized finish with wrap-around flanges, through bolted to doors and pilasters with stainless steel, torx head sex bolts. Hinges operate with field adjustable nylon cams. Cams can be field set in 30-degree increments OR, hinges shall be integral, fabricated from the door and pilaster with no exposed metal parts.
2. Door strike/keeper shall be 6" long and made of heavy-duty extruded aluminum (6436-T5 alloy) with a bright dip anodized finish and secured to the pilasters with stainless steel tamper resistant torx head sex bolts. Bumper shall be made of extruded black vinyl.
3. Latch and housing shall be made of heavy-duty extruded aluminum (6463-T5 alloy). The latch housing shall have a bright dip anodized finish, and the slide bolt and button shall have a black anodized finish.

4. Each door shall be supplied with one bumper and door pull made of chrome plated zamak. Handicapped doors shall be supplied with a second door pull and out swing doors with one door stop made of chrome plated zamak.
5. Coat Hook/Bumper: Combination type, chrome plated Zamak installed on inside face of each stall door.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection: Prior to work of this section, carefully inspect installed work of other trades and verify that work is complete to point where this installation may properly commence.

B. Discrepancies: Do not proceed with installation in areas of discrepancy until discrepancies are fully resolved.

3.02 INSTALLATION

A. Install toilet partitions and other items specified in this Section, anchoring components firmly in place for long life under hard use and in complete accordance with manufacturer's recommendations.

3.03 INSPECTION AND ADJUSTMENT

A. Upon completion of installation and as a condition of acceptance, visually inspect entire work of this section, adjust components for proper operation and straight alignment, and touch-up scratches and abrasions to be completely invisible.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Firefighting devices consist of hand-portable fire extinguishers and metal cabinets.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 PRODUCT HANDLING

A. Protection: Protect firefighting devices before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary at Contractor's expense.

PART 2 - PRODUCTS

2.01 FIRE EXTINGUISHERS

A. Typical: Provide multi-purpose, Model MP-10 dry chemical type for Class A, B and C fires with U.L. rating of 4A-80B:C as manufactured by Larsen's Mfg. Co., or approved equal.

B. At Kitchen: Provide "K Class", Model WC-6L wet chemical type with U.L. rating of 2A:1B:K as manufactured by Larsen's Mfg. Co., or approved equal. Provide manufacturer's standard wall mount bracket #1007.

C. At Electronic Equipment Rooms: Provide Model HT-11 Halotron I type for Class A and B fires as manufactured by Larsen's Mfg. Co., or approved equal.

2.02 FIRE EXTINGUISHER CABINETS

A. Recessed: Construct cabinets from 18 gauge, or heavier, stainless steel with #4 finish. Provide Larsen's Mfg. Co., "Architectural Series" No.SS2409-R, or approved equal, with "Vertical Duo" doors and black vertical die cut lettering. Mount at 48" to top of handle.

B. Semi-Recessed: Construct cabinets from 18 gauge, or heavier, stainless steel with #4 finish. Provide Larsen's Mfg. Co., "Architectural Series" No.SS2409-6R, or approved equal, with "Vertical Duo" doors and black vertical die cut lettering. Mount at 48" to top of handle.

C. Surface Mounted: Construct cabinets from 18 gauge, or heavier, stainless steel with #4 finish. Provide Larsen's Mfg. Co., "Architectural Series" No.SS2409-SM, or approved equal, with "Vertical Duo" doors and black vertical die cut lettering. Mount at 48" to top of handle.

D. Provide fire rated cabinets if required to be installed in a fire rated wall.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Coordination: Coordinate with other trades to ensure proper and adequate provision in framing and wall covering for installation of recessed cabinets.

B. Inspection:
   1. Prior to installation, inspect cabinet recesses, and verify that necessary provisions have been made.
   2. Do not proceed with installation in areas of discrepancy until discrepancies have been fully resolved.

3.02 INSTALLATION

A. Install firefighting devices in full accordance with pertinent regulations and manufacturer's recommendations.

3.03 SERVICE

A. Determine approximate completion date of Work. Inspect, charge, and tag fire extinguishers at date not more than ten days before or less than one day before actual completion date of the Work.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish and install metal accessories called for in Toilet Accessory Schedule.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Use personnel skilled in work required, completely familiar with manufacturers' recommended methods of installation, and thoroughly familiar with requirements of this work.

1.05 PRODUCT HANDLING

A. Protection: Protect toilet and bath accessories before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements necessary at Contractor's expense.

PART 2 - PRODUCTS

2.01 METAL TOILET ACCESSORIES

A. Manufacturers and Accessory Numbers are listed in Toilet Accessory Schedule. Manufacturers who may furnish products for review by Architect are: Bobrick, Bradley, McKinney or American Specialties.

2.02 MATERIALS

A. Stainless Steel: AISI Type 302/304, with Brushed finish, 0.034-inch (22-gage) minimum thickness.

B. Brass: Leaded and unleaded, flat products, ASTM B 19; rods, shapes, forgings, and flat products with finished edges, ASTM B 16; Castings, ASTM B 30.

C. Sheet Steel: Cold-rolled, commercial quality ASTM A 366, 0.04-inch (20-gage) minimum. Surface preparation and metal pretreatment as required for applied finish.

D. Galvanized Steel Sheet: ASTM A 527, G60.

E. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B 456, Type SC 2.

2.03 FASTENERS

A. Provide screws, bolts, and other devices of same material as accessory unit, or of galvanized steel where concealed.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Coordinate with other trades to ensure proper and adequate provision in framing and wall finish for installation of selected accessories.

B. Prior to installation, inspect location of accessories and verify that necessary provisions have been made. Do not proceed with installation in areas of discrepancy until discrepancies have been fully resolved.

3.02 INSTALLATION

A. Install accessories in accordance with manufacturers' recommendations, anchoring components firmly in place.

3.03 TOILET ACCESSORY SCHEDULE

TA1: Surface-Mounted Paper Towel Dispener: Bobrick, B-9262.MBLK, Matte Black Finish

TA2.1 Surface-Mounted Toilet Tissue Dispenser: Kohler, Composed Pivoting Toilet Paper Holder, K-73147-BL, Matte Black finish

TA3: Toilet Seat Cover Dispenser, Bobrick, B-221.MBLK, Matte Black Finish

TA4: Sanitary Napkin Disposal: Bobrick, B-35139.MBLK, Matte Black Finish

TA5.1: Recessed Diaper Changing Station, Koala Kare, KB310-SSRE-MBLK, Matte Black Finish

TA5.2: Surface-Mounted Diaper Changing Station, Koala Kare, KB310-SSWM-MBLK, Matte Black Finish

TA2.2 Surface-Mounted Single Jumbo-Toilet Roll Holder: Bobrick, B-9890.MBLK, Matte Black Finish

TA6.1: Soap Dispenser: Sloan, ESD-2000, Graphite Finish

TA6.2: Soap Dispenser: Kohler, K-28679-BL, Matte Black Finish.

TA7: Single Robe Hook, Kohler, Kumin Robe Hook, K-97897-BL, Matte Black Finish

TA8: Shelf, Bobrick, B-295x14, Finish TBD

TA9: Vertical Grab Bar, Kohler, Purist 18" Grab Bar, K-11892-BL, Matte Black Finish

TA10.1: Horizontal Grab Bar, Kohler, Purist 24" Grab Bar, K-11893-BL, Matte Black Finish

TA10.2: Horizontal Grab Bar, Kohler, Purist 36" Grab Bar, K-11895-BL, Matte Black Finish

TA10.3: Horizontal Grab Bar, Kohler, Purist 42" Grab Bar, K-11896-BL, Matte Black Finish

TA10.4: Horizontal Grab Bar, Custom to Match Kohler Purist, 60" Length, Matte Black Finish (subject to change – pending LN confirmation)

TA11: Utility Shelf, Bobrick, B-239

M1: Frameless Mirror, Custom-fabricated, Bendheim BIGNY-204149 Laminated, Colored, Refer to drawings for size & design

M2: Framed Mirror, Mirror Image, Custom-fabricated clear mirror with matte black metal frame, 30" dia., Refer to drawings for design (subject to change – pending LN confirmation)

M3: Framed Mirror, Mirror Image, Custom-fabricated clear mirror with matte black metal frame, 36" x 66", Refer to drawings for design (subject to change – pending LN confirmation)

~~M4: Framed Mirror, Mirror Image, Custom-fabricated clear mirror with brown vinyl strap and brass hardware, 36" dia., Refer to drawings for design (subject to change pending LN confirmation)~~

M5: Full Length Mirror, Mirror Image, Custom-fabricated clear mirror with black powder coated frame and bronze interior frame, 24" x 67", refer to drawings for design (subject to change – pending LN confirmation)

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide miscellaneous specialties specified.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Furnish at least one person, present at all times, thoroughly familiar with installation requirements of each item, to personally supervise installation.

1.05 PRODUCT HANDLING

A. Protection: Protect miscellaneous specialty items before, during, and after installation. Protect installed work and materials of other trades.

B. Replacements: In event of damage, immediately make repairs and replacements at Contractor's expense.

PART 2 - PRODUCTS

2.01 RAPID ENTRY SYSTEM

A. Provide Knox-Box emergency entry key box by Knox Co., 800-552-5669, or approved equal. Provide 3200 Series recessed unit in bronze color. Contractor to contact local fire department to apply for authorization to order box. Orders are not accepted without authorized signature of local fire official.

B. Knox Elevator Box Model: 1403, bronze color, heavy-duty UL 1037 listed, surface mount without UL listed alarm tamper switches. 10 gauge plate steel housing, 100% welded. Door: 10 gauge steel, lock protecting hardplate, 1” security overlap. Lock shall be UL listed. Lock shall have 1/8” stainless steel dust cover with tamper seal mounting capability.

2.02 INTERIOR SIGNAGE

A. Provide code-required interior signage. Directional, office, conference room, etc. Signage will be provided by Owner. All sign types will be thermoformed and ADA compliant.

B. Signs requiring a symbol (restrooms, stairs, etc.) Will be an 8 ½" tall x 8 ½" wide sign with a modern symbol (man/woman, stair, fire, etc.) Cut out. Symbol to be selected by architect. Other room signs will be 3" tall x 8 ½" wide. Sign backgrounds will match the field wall color. Provide room number and name on each sign in contrasting color to background. Braille will be the same color as the background.

C. All signs will be mounted with a back-plate in the same color as the background. The size of back-plate will be 1" smaller on all sides to create a shadow/conceal mount. If a sign is mounted on glass, a back-plate in the same overall sign dimensions should be provided to conceal mounting.

D. Verify design and finishes with architect. Prior to final pricing and fabrication, coordinate the design with architect for any non-code required signage.

2.03 WALL PROTECTION

A. CG1: Corner Guard, Surface-Mounted, End Cap
Manufacturer: Acrovyn
Product: SCO-8
Color: Stainless Steel
Size: 3 ½" wing, 0.6" thickness
Height: Full-height, refer to drawings for more information
Installation Method: adhered

B. CG2: Corner guard, Surface-Mounted, End Cap
Manufacturer: Acrovyn
Product: CO-08
Color: Stainless Steel
Size: 3" wing
Height: Full-height, refer to drawings for more information
Installation Method: Adhered

C. FRP-01: Fiberglass Reinforced Panel, Type 1
Manufacturer: Marlite
Product: Standard FRP, Pebbled
Color: P 100 White
Note: Full-height unless otherwise noted

D. FRP-02: Fiberglass Reinforced Panel, Type 2
Manufacturer: Marlite
Product: Standard FRP, Pebbled
Color: P 907 Black
Note: Located at underside of counter on server side of front bar

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Prior to installation, verify items may be installed in accordance with manufacturers' recommendations.

B. Notify Architect of conditions that would adversely affect installation.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install miscellaneous specialties in strict accordance with manufacturers' current recommendations and instructions.

3.03 ADJUSTMENT AND CLEANING

A. Verify that trim is in place and adjust components.

B. Remove labels from equipment and remove packing materials from job site.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Work covered by this section includes furnishing of and paying for all materials, labor, equipment, licenses, taxes, and other items required for execution and completion of all work under this section.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

PART 2 - PRODUCTS

2.01 DOCK LEVELERS

A. MECHANICAL DOCK LEVELERS shall be Model RHM4000 as manufactured by Rite-Hite, or an approved

B. Recessed adjustable dock levelers shall be sized as shown on the drawings, with a lip dimension as required and a 5,000 lb. capacity rating. Unit to have an operational range of 12” above and below dock level.

C. Equip each unit with two (2), 12” high x 4” deep molded dock bumpers

D. Dock leveler shall meet ANSI MH30.1-2000 test load specifications with proper documentation from a 3rd party.

E. Platform shall have a minimum of (8) interior deck beams plus external working range toeguards.

F. Provide safety stops to limit fall of platform to 3” and 7” below dock. Safety stops to be integral part of manufacturer's standard dock levelers.

G. Toeguard thickness is 11 gage (0.120 inch).

H. Ramp control to have a 9 tooth pawl and ratchet bar for positive engagement through full working range.

I. Positive acting Safe-T-Strut maintenance support system will support lip and deck. This system must withstand a 10,000 lb. moving load and provide OSHA approved lock-out/tag-out capabilities.

J. Levelers shall have ramp flex of 4" to compensate for unlevel trailer beds. Rear hinges shall be fixed and shall not raise above floor level.

K. Lip assist system shall provide positive lip extension and shall be yieldable.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the substrates and conditions under which the dock equipment is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer's detailed instructions.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation, conduct the following tests to ensure the proper construction and operation:
   1. Pretest to 100% of rated capacity.

3.04 ADJUST AND CLEAN

A. Make necessary adjustments for safe, efficient operation.

B. After installation, restore marred and abraded surfaces to original condition.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Provide window shades, curtains and accessories.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 QUALITY ASSURANCE

A. Comply with governing codes/regulations. Provide products of acceptable manufacturers with satisfactory use in similar service for three years. Use experienced installers. Deliver, handle and store materials in accordance with manufacturer's instructions.

1.05 WARRANTY

A. Ten-year warranty on manually operated components, except bead chain which is a maintenance / service item.

B. Ten-year warranty on shade cloth with provision that it will not deteriorate, sag or warp and will remain fit for use for the full warranty period when used as an interior rollershade.

C. Manufacturer to warrant its hardware components to be free from defects in material and workmanship under the normal and proper use for a period of ten (10) years from date of invoice.

PART 2 - PRODUCTS

2.01 WINDOW SHADES

A. Manufacturer: MechoShade Systems, Inc., Long Island City, New York 11101, USA.
   1. MechoShade manually operated units.

B. WS-01: Window Shades, Type 1
Manufacturer: Mechoshade
Type: Mecho/5
Shadecloth: SoHo Elavate, Charcoal, 3% Open
Notes: Surface-mounted to exposed structure where noted on drawings

C. Manual Shade System: Pre-engineered unit with one-piece molded sprockets and a linear disc brake opposed to a flat steel backing plate and concealed variable-adjustment mechanism. Shade mechanism shall be adjustable from 100% friction (static mode) with infinite positions to 15% friction (dynamic mode) with only pre-selected positions. The operator shall be a side-mounted gear and sprocket mechanism located within the drive-end bracket. The shade cloth shall be removable with a snap-on and snap-off mounting (Snap-Loc) spline without having to remove the shade tube.

D. SnapLoc Fascia: Extruded aluminum SnapLoc fascia which continuously fits on the end and center brackets as a one-piece section over two or more shade bands.

2.02 CURTAINS

A. WS-02: Window Shades, Type 2 (subject to change)
Fabric: Valley Forge Fabrics, Mood Velvet, Melancholy
Hardware: Houles City Collection – Murray Finals
64190 Rings
64193 Wall Brackets
68244 Tie Back Hooks in Matte Brushed Black

B. Fabricate curtains to comply with following requirements:
1. Fullness: 2-1/2 times
2. Headings pinch pleated, tacked top and bottom 4" permanent heavy duty crinoline with double turn of fabric.
3. Side hem to be 1-1/2" doubled.
4. Bottom hem to be 4" doubled.
5. Weights shall be 1" square lead, covered at all corners and seams.
6. Headings to have 1/4" clearance from ceilings.
7. Bottom to ride 3/4" from floor covering and/or 1/2" from tops of built-in cabinets or raised window sills.
8. Serge all seams with an overlocking stitch.
9. Verify length of draperies on job site prior to fabrication.
10. Hooks to be heavy duty type zinc coated or cadmium finish.

PART 3- EXECUTION

3.01 INSTALLATION

A. Take field measurements prior to the fabrication to ensure fit.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Machine room-less hydraulic passenger elevators as shown and specified. Elevator work includes:
   1. Standard pre-engineered hydraulic passenger elevators.
   2. Elevator car enclosures, hoistway entrances and signal equipment.
   3. Operation and control systems.
   4. Jack(s).
   5. Accessibility provisions for physically disabled persons.
   6. Equipment, machines, controls, systems and devices as required for safely operating the specified elevators at their rated speed and capacity.
   7. Materials and accessories as required to complete the elevator installation.

B. Related Sections:
   1. Division 1 General Requirements: Meet or exceed all referenced sustainability requirements.
   2. Division 3 Concrete: Installing inserts, sleeves and anchors in concrete.
   3. Division 4 Masonry: Installing inserts, sleeves and anchors in masonry.
   4. Division 5 Metals:
      a. Providing hoist beams, pit ladders, steel framing, auxiliary support steel and divider beams for supporting guide-rail brackets.
      b. Providing steel angle sill supports and grouting hoistway entrance sills and frames.
   5. Division 9 Finishes: Providing elevator car finish flooring and field painting unfinished and shop primed ferrous materials.
   6. Division 16 Sections:
      a. Providing electrical service to elevators, including fused disconnect switches where permitted. (note: fused disconnect switch to be provided as part of elevator manufacture product, see section 2.11 Miscellaneous elevator components for further details.)
      b. Emergency power supply, transfer switch and auxiliary contacts.
      c. Heat and smoke sensing devices.
      d. Convenience outlets and illumination in control room (if applicable), hoistway and pit.
   7. Division 22 Plumbing
      a. Sump pit and oil interceptor.
   8. Division 23 Heating, Ventilation and Air Conditioning
      a. Heating and ventilating hoistways and/or control room.

C. Work Not Included: General contractor shall provide the following in accordance with the requirements of the Model Building Code and ANSI A17.1 Code. For specific rules, refer to ANSI

D. A17.1, Part 3 for hydraulic elevators. State or local requirements must be used if more stringent. The cost of this work is not included in the TK Elevator's proposal, since it is a part of the building construction.

1. Elevator hoist beam to be provided at top of elevator shaft. Beam must be able to accommodate proper loads and clearances for elevator installation and operation.
2. Supply in ample time for installation by other trades, inserts, anchors, bearing plates, brackets, supports and bracing including all setting templates and diagrams for placement.
3. Hatch walls require a minimum two hours of fire rating. Hoistway should be clear and plumb with variations not to exceed 1/2" at any point.
4. Elevator hoistways shall have barricades, as required.
5. Install bevel guards at 75° on all recesses, projections or setbacks over 2" (4" for A17.1 2000 areas) except for loading or unloading.
6. Provide rail bracket supports at pit, each floor and roof. For guide rail bracket supports, provide divider beams between hoistway at each floor and roof.
7. Pit floor shall be level and free of debris. Reinforce dry pit to sustain normal vertical forces from rails and buffers.
8. Where pit access is by means of the lowest hoistway entrance, a vertical ladder of non-combustible material extending 42" minimum, (48" minimum for A17.1-2000 areas) shall be provided at the same height, above sill of access door or handgrips.
9. All wire and conduit should run remote from the hoistways.
10. When heat, smoke or combustion sensing devices are required, connect to elevator control cabinet terminals. Contacts on the sensors should be sided for 12 volt D.C.
11. Install and furnish finished flooring in elevator cab.
12. Finished floors and entrance walls are not to be constructed until after sills and door frames are in place. Consult elevator contractor for rough opening size. The general contractor shall supply the drywall framing so that the wall fire resistance rating is maintained, when drywall construction is used.
13. Where sheet rock or drywall construction is used for front walls, it shall be of sufficient strength to maintain the doors in true lateral alignment. Drywall contractor to coordinate with elevator contractor.
14. Before erection of rough walls and doors; erect hoistway sills, headers, and frames. After rough walls are finished; erect fascias and toe guards. Set sill level and slightly above finished floor at landings.
15. To maintain legal fire rating (masonry construction), door frames are to be anchored to walls and properly grouted in place.
16. The elevator wall shall interface with the hoistway entrance assembly and be in strict compliance with the elevator contractor's requirements.
17. General Contractor shall fill and grout around entrances, as required.
18. All walls and sill supports must be plumb where openings occur.

19. Locate a light fixture (200 lx / 19 fc) and convenience outlet in pit with switch located adjacent to the access door.
20. Provide telephone line, light fixture (200 lx / 19 fc), and convenience outlet in the hoistway at the landing where the elevator controller is located. Typically this will be at the landing above the 1st floor. Final location must be coordinated with elevator contractor.
21. As indicated by elevator contractor, provide a light outlet for each elevator, in center of hoistway.
22. For signal systems and power operated door: provide ground and branch wiring circuits.
23. For car light and fan: provide a feeder and branch wiring circuits to elevator control cabinet.
24. Controller landing wall thickness must be a minimum of 8 1/2 inches thick. This is due to the controller being mounted on the second floor landing in the door frame on the return side of the door. For center opening doors, the controller is located on the right hand frame (from inside the elevator cab looking out). These requirements must be coordinated between the general contractor and the elevator contractor.
25. Cutting, patching and recesses to accommodate hall button boxes, signal fixtures, etc..

1.02 SUBMITTALS

A. Product data: When requested, the elevator contractor shall provide standard cab, entrance and signal fixture data to describe product for approval.

B. Shop drawings:
   1. Show equipment arrangement in the corridor, pit, and hoistway and/or optional control room. Provide plans, elevations, sections and details of assembly, erection, anchorage, and equipment location.
   2. Indicate elevator system capacities, sizes, performances, safety features, finishes and other pertinent information.
   3. Show floors served, travel distances, maximum loads imposed on the building structure at points of support and all similar considerations of the elevator work.
   4. Indicate electrical power requirements and branch circuit protection device recommendations.

C. Powder Coat paint selection: Submit manufacturer’s standard selection charts for exposed finishes and materials.

D. Plastic laminate selection: Submit manufacturer’s standard selection charts for exposed finishes and materials.

E. Metal Finishes: Upon request, standard metal samples provided.

F. Operation and maintenance data. Include the following:
   1. Owner’s manuals and wiring diagrams.

2. Parts list, with recommended parts inventory.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: An approved manufacturer with minimum 15 years of experience in manufacturing, installing, and servicing elevators of the type required for the project.
   1. The manufacturer of machines, controllers, signal fixtures, door operators cabs, entrances, and all other major parts of elevator operating equipment.
      a. The major parts of the elevator equipment shall be manufactured by the installing company, and not be an assembled system.
   2. The manufacturer shall have a documented, on-going quality assurance program.
   3. ISO-9001:2000 Manufacturer Certified
   4. ISO-14001:2004 Environmental Management System Certified
   5. LEED Gold certified elevator manufacturing facility.

B. Installer Qualifications: The manufacturer or an authorized agent of the manufacturer with not less than 15 years of satisfactory experience installing elevators equal in character and performance to the project elevators.

C. Regulatory Requirements:
   1. ASME A17.1 Safety Code for Elevators and Escalators, latest edition or as required by the local building code.
   2. Building Code: National.
   3. NFPA 70 National Electrical Code.
   4. NFPA 80 Fire Doors and Windows.
   5. Americans with Disabilities Act - Accessibility Guidelines (ADAAG)
   6. Section 407 in ICC A117.1, when required by local authorities
   7. CAN/CSA C22.1 Canadian Electrical Code
   8. CAN/CSA B44 Safety Code for Elevators and Escalators.
   9. California Department of Public Health Standard Method V1.1–2010, CA Section 01350

D. Fire-rated entrance assemblies: Opening protective assemblies including frames, hardware, and operation shall comply with ASTM E2074, CAN4-S104 (ULC-S104), UL10(b), and NFPA Standard 80. Provide entrance assembly units bearing Class B or 1 1/2 hour label by a Nationally Recognized Testing Laboratory (2 hour label in Canada).

E. Inspection and testing:

   1. Elevator Installer shall obtain and pay for all required inspections, tests, permits and fees for elevator installation.
   2. Arrange for inspections and make required tests.
   3. Deliver to the Owner upon completion and acceptance of elevator work.

F. Sustainable Product Qualifications:
   1. Environmental Product Declaration:

a. GOOD: If Product Category Rules (PCR) are not available, produce a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that has at least a cradle to gate se.
b. BEST: If Product Category Rules (PCR) are available, produce and publish an Environmental Product Declaration (EPD) based on a critically reviewed life-cycle assessment conforming to ISO 14044, with external verification recognized by the EPD program operator.

2. Material Transparency:
   a. GOOD: Provide Health Product Declaration at any level
   b. BETTER: Provide Health Product Declaration (HPD v2 or later). Complete, published declaration with full disclosure of known hazards, prepared using the Health Product Declaration Collaborative's "HPD builder" on-line tool.
   c. BEST: Cradle to Cradle Material Health Certificate v3, Bronze level or higher.
3. LEED v4 – Provide documentation for all Building Product Disclosure AND Optimization credits in LEED v4 for product specified.
4. Living Building Challenge Projects: Provide Declare label for products specified.

1.04 DELIVERY, STORAGE AND HANDLING

A. Manufacturing shall deliver elevator materials, components and equipment and the contractor is responsible to provide secure and safe storage on job site.

1.05 PROJECT CONDITIONS

A. Temporary Use: Elevators shall not be used for temporary service or for any other purpose during the construction period before Substantial Completion and acceptance by the purchaser unless agreed upon by Elevator Contractor and General Contractor with signed temporary agreement.

1.06 WARRANTY

A. Warranty: Submit elevator manufacturer's standard written warranty agreeing to repair, restore or replace defects in elevator work materials and workmanship not due to ordinary wear and tear or improper use or care for 12 months after final acceptance.

1.07 MAINTENANCE

A. Furnish maintenance and call back service for a period of 12 months for each elevator after completion of installation or acceptance thereof by beneficial use, whichever is earlier, during normal working hours excluding callbacks.
   1. Service shall consist of periodic examination of the equipment, adjustment, lubrication, cleaning, supplies and parts to keep the elevators in proper operation. Maintenance work, including emergency call back repair service, shall be performed by trained employees of the elevator contractor during regular working hours.

2. Submit parts catalog and show evidence of local parts inventory with complete list of recommended spare parts. Parts shall be produced by manufacturer of original equipment.
3. Manufacturer shall have a service office and full time service personnel within a 100 mile radius of the project site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Design based around TK Elevator's endura Machine Room-Less hydraulic elevator.

2.02 MATERIALS, GENERAL

A. All Elevator Cab materials including frame, buttons, lighting, wall and ceiling assembly, laminates and carpet shall have an EPD and an HPD, and shall meet the California Department of Public Health Standard Method V1.1–2010, CA Section 01350 as mentioned in 1.03.9 of this specification.

B. Colors, patterns, and finishes: As selected by the Architect from manufacturer's full range of standard colors, patterns, and finishes.

C. Steel:
   1. Shapes and bars: Carbon.
   2. Sheet: Cold-rolled steel sheet, commercial quality, Class 1, matte finish.
   3. Finish: Factory-applied baked enamel for structural parts, powder coat for architectural parts. Color selection must be based on elevator manufacture's standard selections.

D. Plastic laminate: Decorative high-pressure type, complying with NEMA LD3, Type GP-50 General Purpose Grade, nominal 0.050" thickness. Laminate selection must be based on elevator manufacture's standard selections.

E. Flooring by others.

2.03 HOISTWAY EQUIPMENT

A. Platform: Fabricated frame of formed or structural steel shapes, gusseted and rigidly welded with a wood sub-floor. Underside of the platform shall be fireproofed. The car platform shall be designed and fabricated to support one-piece loads weighing up to 25% of the rated capacity.

B. Sling: Steel stiles bolted or welded to a steel crosshead and bolstered with bracing members to remove strain from the car enclosure.

C. Guide Rails: Steel, omega shaped, fastened to the building structure with steel brackets.

D. Guides: Slide guides shall be mounted on top and bottom of the car.

E. Buffers: Provide substantial buffers in the elevator pit. Mount buffers on continuous channels fastened to the elevator guide rail or securely anchored to the pit floor. Provide extensions if required by project conditions.

F. Jack: A jack unit shall be of sufficient size to lift the gross load the height specified. Factory test jack to ensure adequate strength and freedom from leakage. Brittle material, such as gray cast iron, is prohibited in the jack construction. Provide the following jack type: Twin post holeless telesic 2-stage. Two jacks piped together, mounted one on each side of the car with each having two telesic sections designed to extend in a synchronized manner when oil is pumped into the Assembly. Each jack section will be guided from within the casing or the plunger assembly used to house the section. Each plunger shall have a high pressure sealing system which will not allow for seal movement or displacement during the course of operation. Each Jack Assembly shall have a check valve built into the assembly to allow for automatically re-syncing the two plunger sections by moving the jack to its fully contracted position. The jack shall be designed to be mounted on the pit floor or in a recess in the pit floor. Each jack section shall have a bleeder valve to discharge any air trapped in the section..

G. Automatic Self-Leveling: Provide each elevator car with a self-leveling feature to automatically bring the car to the floor landings and correct for over travel or under travel. Self-leveling shall, within its zone, be automatic and independent of the operating device. The car shall be maintained approximately level with the landing irrespective of its load.

H. Wiring, Piping, and Oil: Provide all necessary hoistway wiring in accordance with the National Electrical Code. All necessary code compliant pipe and fittings shall be provided to connect the power unit to the jack unit. Provide proper viscosity grade inherently biodegradable oil as specified by the manufacturer of the power unit (see Power Unit section 2.04.G for further details)

I. Pit moisture/water sensor located approximately 1 foot above the pit floor to be provided. Once activated, elevator will perform “flooded pit operation”, which will run the car up to the designated floor, cycle the doors and shut down and trip the circuit breaker shunt to remove 3 phase power from all equipment, including pit equipment.

J. Motorized oil line shut-off valve shall be provided that can be remotely operated from the controller landing service panel. Also a means for manual operation at the valve in the pit is required.

2.04 POWER UNIT

A. Power Unit (Oil Pumping and Control Mechanism): A self-contained unit located in the elevator pit consisting of the following items:
    1. NEMA 4/Sealed Oil reservoir with tank cover including vapor removing tank breather

2. An oil hydraulic pump.
3. An electric motor.
4. Electronic oil control valve with the following components built into single housing; high pressure relief valve, check valve, automatic unloading up start valve, lowering and leveling valve, and electro-magnetic controlling solenoids.

B. Pump: Positive displacement type pump specifically manufactured for oil-hydraulic elevator service. Pump shall be designed for steady discharge with minimum pulsation to give smooth and quiet operation. Output of pump shall not vary more than 10 percent between no load and full load on the elevator car.

C. Motor: Standard manufacture motor specifically designed for oil-hydraulic elevator service. Duty rating – motors shall be capable of 80 starts per hour with a 30% motor run time during each start.

D. Oil Control Unit: The following components shall be built into a single housing. Welded manifolds with separate valves to accomplish each function are not acceptable. Adjustments shall be accessible and be made without removing the assembly from the oil line.
   1. Relief valve shall be adjustable and be capable of bypassing the total oil flow without increasing back pressure more than 10 percent above that required to barely open the valve.
   2. Up start and stop valve shall be adjustable and designed to bypass oil flow during start and stop of motor pump assembly. Valve shall close slowly, gradually diverting oil to or from the jack unit, ensuring smooth up starts and up stops.
   3. Check valve shall be designed to close quietly without permitting any perceptible reverse flow.
   4. Lowering valve and leveling valve shall be adjustable for down start speed, lowering speed, leveling speed and stopping speed to ensure smooth "down" starts and stops. The leveling valve shall be designed to level the car to the floor in the direction the car is traveling after slowdown is initiated.
   5. Provided with constant speed regulation in both up and down direction. Feature to compensate for load changes, oil temperature, and viscosity changes.
   6. Solid State Starting: Provide an electronic starter featuring adjustable starting currents.
   7. A secondary hydraulic power source (powered by 110VAC single phase) must be provided. This is required to be able to raise (reposition) the elevator in the event of a system component failure (i.e. pump motor, starter, etc.)
   8. Oil Type: Provide a zinc free, inherently biodegradable lubricant formulated with premium base stocks to provide outstanding protection for demanding hydraulic systems, especially those operating in environmentally sensitive areas.

2.05 HOISTWAY ENTRANCES

A. Doors and Frames: Provide complete hollow metal type hoistway entrances at each hoistway opening bolted\knock down construction.
    1. Manufacturer's standard entrance design consisting of hangers, doors, hanger supports, hanger covers, fascia plates (where required), sight guards, and necessary hardware.
    2. Main landing door & frame finish: ASTM A1008 steel panels, factory applied powder coat finish with factory-applied powder coat finish entrance frame.
    3. Typical door & frame finish: ASTM A366 steel panels, factory applied powder coat enamel finish with factory-applied powder coat finish entrance frame.

B. Integrated Control System: the elevator controller to be mounted to hoistway entrance above 1st landing. The entrance at this level, shall be designed to accommodate the control system and provide a means of access to critical electrical components and troubleshooting features. See section 2.09 Control System for additional requirements.

C. At the controller landing, the hoistway entrance frame shall have space to accommodate and provide a lockable means of access (group 2 security) to a 3 phase circuit breaker. See section 2.11 Miscellaneous Elevator Components for further details

D. Interlocks: Equip each hoistway entrance with an approved type interlock tested as required by code. Provide door restriction devices as required by code.

E. Door Hanger and Tracks: Provide sheave type two point suspension hangers and tracks for each hoistway horizontal sliding door.
    1. Sheaves: Polyurethane tires with ball bearings properly sealed to retain grease.
    2. Hangers: Provide an adjustable device beneath the track to limit the up-thrust of the doors during operation.
    3. Tracks: Drawn steel shapes, smooth surface and shaped to conform to the hanger sheaves.

F. Hoistway Sills: Extruded metal, with groove(s) in top surface. Provide mill finish on aluminum.

2.06 PASSENGER ELEVATOR CAR ENCLOSURE

A. Car Enclosure:
    1. Walls: Cab type TKAP, reinforced cold-rolled steel with two coats factory applied baked enamel finish, with applied vertical wood core panels covered on both sides with high pressure plastic laminate.
    2. Reveals and frieze: a. Reveals and frieze: Powder Coated
    3. Canopy: Cold-rolled steel with hinged exit.
    4. Ceiling: Suspended type, LED lighting with translucent diffuser mounted in a metal frame. Framework shall be finished with a factory applied powder coat finish.
    5. Cab Fronts, Return, Transom, Soffit and Strike: Provide panels faced with brushed stainless steel

6. Doors: Horizontal sliding car doors reinforced with steel for panel rigidity. Hang doors on sheave type hangers with polyurethane tires that roll on a polished steel track and are guided at the bottom by non-metallic sliding guides.
    a. Door Finish: Stainless steel panels: No. 4 brushed finish.
    b. Cab Sills: Extruded aluminum, mill finish.
7. Handrail: Provide 1.5' diameter cylindrical metal on side and rear walls on front opening cars and side walls only on front and rear opening cars. Handrails shall have a stainless steel, no. 4 brushed finish.
8. Ventilation: Manufacturer's standard exhaust fan, mounted on the car top.
9. Protection pads and buttons: Not required

B. Car Top Inspection: Provide a car top inspection station with an "Auto-Inspection" switch, an "emergency stop" switch, and constant pressure "up and down" direction and safety buttons to make the normal operating devices inoperative. The station shall give the inspector complete control of the elevator. The car top inspection station shall be mounted in the door operator assembly.

2.07 DOOR OPERATION

A. Door Operation: Provide a direct or alternating current motor driven heavy duty operator designed to operate the car and hoistway doors simultaneously. The door control system shall be digital closed loop and the closed loop circuit shall give constant feedback on the position and velocity of the elevator door. The motor torque shall be constantly adjusted to maintain the correct door speed based on its position and load. All adjustments and setup shall be through the computer based service tool. Door movements shall follow a field programmable speed pattern with smooth acceleration and deceleration at the ends of travel. The mechanical door operating mechanism shall be arranged for manual operation in event of power failure. Doors shall automatically open when the car arrives at the landing and automatically close after an adjustable time interval or when the car is dispatched to another landing. AC controlled units with oil checks, or other deviations are not acceptable.
    1. No Un-Necessary Door Operation: The car door shall open only if the car is stopping for a car or hall call, answering a car or hall call at the present position or selected as a dispatch car.
    2. Door Open Time Saver: If a car is stopping in response to a car call assignment only (no coincident hall call), the current door hold open time is changed to a shorter field programmable time when the electronic door protection device is activated.
    3. Double Door Operation: When a car stops at a landing with concurrent up and down hall calls, no car calls, and no other hall call assignments, the car door opens to answer the hall call in the direction of the car's current travel. If an onward car call is not registered before the door closes to within 6 inches of fully closed, the travel shall reverse and the door shall reopen to answer the other call.
    4. Nudging Operation: The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If door closing is prevented for

a field programmable time, a buzzer shall sound. When the obstruction is removed, the door shall begin to close at reduced speed. If the infra-red door protection system detects a person or object while closing on nudging, the doors shall stop and resume closing only after the obstruction has been removed.

5. Door Reversal: If the doors are closing and the infra-red beam(s) is interrupted, the doors shall reverse and reopen. After the obstruction is cleared, the doors shall begin to close.
6. Door Open Watchdog: If the doors are opening, but do not fully open after a field adjustable time, the doors shall recycle closed then attempt to open six times to try and correct the fault.
7. Door Close Watchdog: If the doors are closing, but do not fully close after a field adjustable time, the doors shall recycle open then attempt to close six times to try and correct the fault.
8. Door Close Assist: When the doors have failed to fully close and are in the recycle mode, the door drive motor shall have increased torque applied to possibly overcome mechanical resistance or differential air pressure and allow the door to close.

B. Door Protection Device: Provide a door protection system using microprocessor controlled infra-red light beams. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen.

2.08 CAR OPERATING STATION

A. Car Operating Station, General: The main car control in each car shall contain the devices required for specific operation mounted in an integral swing return panel requiring no applied faceplate. Wrap return shall have a brushed stainless steel finish. The main car operating panel shall be mounted in the return and comply with handicap requirements. Pushbuttons that illuminate using long lasting LED's shall be included for each floor served, and emergency buttons and switches shall be provided per code. Switches for car light and accessories shall be provided.

B. Emergency Communications System: Integral phone system provided.

C. Auxiliary Operating Panel:

D. Column Mounted Car Riding Lantern: A car riding lantern shall be installed in the elevator cab and located in the entrance. The lantern, when illuminated, will indicate the intended direction of travel. The lantern will illuminate and a signal will sound when the car arrives at a floor where it will stop. The lantern shall remain illuminated until the door(s) begin to close.

E. Special Equipment: Not Applicable

F. Digital Services: Cloud-based IoT monitoring system comes standard with these options:

Remote Monitoring with Application Programming Interface (API) Integration

ADA Phone - Code Compliant Cellular Connectivity

A17.1 2019 Code - Enhanced Communications

Smart Device Elevator Calling with occupant app API integration

2.09 CONTROL SYSTEMS

A. Controller: Shall be integrated in a hoistway entrance jamb. Should be microprocessor based, software oriented and protected from environmental extremes and excessive vibrations in a NEMA 1 enclosure. Control of the elevator shall be automatic in operation by means of push buttons in the car numbered to correspond to floors served, for registering car stops, and by "up-down" push buttons at each intermediate landing and "call" push buttons at terminal landings.

B. Service Panel – to be located outside the hoistway in the controller entrance jamb and shall provide the following functionality/features:
   1. Access to main control board and CPU
   2. Main controller diagnostics
   3. Main controller fuses
   4. Universal Interface Tool (UIT)
   5. Remote valve adjustment
   6. Electronic motor starter adjustment and diagnostics
   7. Operation of pit motorized shut-off valve with LED feedback to the state of the valve in the pit
   8. Operation of auxiliary pump/motor (secondary hydraulic power source)
   9. Operation of electrical assisted manual lowering
   10. Provide male plug to supply 110VAC into the controller
   11. Run/Stop button

C. Automatic Light and Fan shut down: The control system shall evaluate the system activity and automatically turn off the cab lighting and ventilation fan during periods of inactivity. The settings shall be field programmable.

D. Emergency Power Operation: (Battery Lowering 10D-0C) When the loss of normal power is detected, a battery lowering feature is to be activated. The elevator will lower to a predetermined level and open the doors. After passengers have exited the car, the doors will close and the car will shutdown. When normal power becomes available, the elevator will automatically resume operation. The battery lowering feature is included in the elevator contract and does not utilize a building-supplied standby power source.

E. Special Operation: Not Applicable

F. Digital Services:

Cloud-based IoT Monitoring System (standard): Contractor shall provide a cloud-based IoT (internet of things) monitoring system capable of tracking door movements and timing, trips, power cycles, car calls, out-of-service events and modes. This observation will continue 24/7 and it shall be capable of providing service technicians a minimum of three recommended solutions for defined failure events and automatically dispatch service technicians in the event of failure(s) while sending notifications to end users of changes in their equipment's state via both email and mobile device. Access to IoT and related equipment data and status will be made available in both a web portal and mobile application secured by password and username with at least two-factor authentication. Finally, this system must be self-contained and not require internet provision by others.

Along with the monitoring system, options are available.

Remote Monitoring with Application Programming Interface (API) Integration: Contractor shall provide a portal and mobile device application (app) that communicates relevant service and operational information such as elevator operational status, open service call tickets, call ticket history and performance and service history. This system shall provide a REST application programming interface (API) capable of transmitting relevant information from the cloud-based IoT monitoring system. This data includes equipment operational status, door movements, service and maintenance history, traffic statistics and failure alerts.

ADA Phone – Code Compliant Cellular Connectivity: Contractor shall provide a phone service through a self-contained cellular based VoIP system. This system shall meet code, include a backup battery capable of powering the emergency communication equipment for 4+ hours in the event of a power outage. The solution shall have remote monitoring capability to ensure continuous connectivity with a means of remote troubleshooting. Remote monitoring capability shall include, at a minimum, the ability to monitor connectivity and power supply. Remote monitoring shall be capable of providing local alerts to response personnel when on-site intervention is required.

A17.1 2019 Code – Enhanced Communications: For jobs installed under enforcement of 2018 International Building Code or ASME A17.1-2019/CSA B44:19 Safety Code, contractor will provide a video camera necessary for viewing the elevator cab interior floor as well as a position indicator display in the cab operating panel capable of providing means of two-way, text-based communication when the emergency call button is engaged in the elevator car. These components, and associated cloud-based monitoring platform, will be non-proprietary in nature, allowing customization on where to direct emergency calls, while offering capability for any party to provide the emergency monitoring services.

Smart Device Elevator Calling with Occupant app API Integration: Contractor will provide an elevator calling application for smart devices (app) that can be accessed through Android and IOS smart device operating systems. This calling service shall be accomplished on both, Destination Dispatch and Traditional ETA elevator control system applications. Furthermore, a single, common and consistent app shall have the same user experience and user interface on both Destination Dispatch and Traditional ETA dispatching control systems. To enable mobile calling functionality without creating unnecessary wear on elevator components resulting from false calls, proximity detection beacons shall be installed in the elevator lobby at each floor. These beacons shall detect user smart devices and restrict calling of elevators when the user is not within a pre-configured range of elevator entrance. Beacon-based proximity detection distance must be configurable to accommodate various building and floor layouts. Once Bluetooth signal is detected, the user can place a floor call directly from their handheld or wearable device. The elevator calling app shall remove the need for interaction with hall fixtures, buttons or kiosks. This system shall be capable of placing an automatic call to a user-configured destination floor automatically based on both location in building (floor) and time of day. App users shall be able to configure their own source or starting floor, destination floor and schedule of automatic calling service, and be able to configure multiple automatic calling services and routines. System shall have reasonable ability to auto-provision users from access control system and not require duplicate entry of users for access control purposes. Finally, all services above shall be made available via an application programming interface (API) so that a 3rd party or tenant occupant app could be integrated with elevator smart device calling service so that users could receive multiple occupant experience-based services in a single, common, 3rd party mobile device application (app).

2.10 HALL STATIONS

A. Hall Stations, General: Buttons shall illuminate to indicate call has been registered at that floor for the indicated direction.
    1. Provide one pushbutton riser with faceplates having a brushed stainless steel finish.
        a. Phase 1 firefighter’s service key switch, with instructions, shall be incorporated into the hall station at the designated level.

B. Floor Identification Pads: Provide door jamb pads at each floor. Jamb pads shall comply with Americans with Disabilities Act (ADA) requirements.

C. Hall Position Indicator: Not Applicable

D. Hall lanterns: Not Applicable

E. Special Equipment: Not Applicable

2.11 MISCELLANEOUS ELEVATOR COMPONENTS

A. Oil Hydraulic Silencer: Install multiple oil hydraulic silencers (muffler device) at the power unit location. The silencers shall contain pulsation absorbing material inserted in a blowout proof housing.

B. Lockable three phase circuit breaker with auxiliary contact with shunt trip capability to be provided. Circuit breaker to be located behind locked panel (Group 2 security access) at controller landing entrance jamb and should be sized according to the National Electrical Code.

C. Lockable single phase 110V circuit breaker for cab light and fan to be provided. Circuit breaker to be located behind locked panel (Group 2 security access) at controller landing entrance jamb should be sized according to the National Electrical Code

PART 3 EXECUTION

3.01 EXAMINATION

A. Before starting elevator installation, inspect hoistway, hoistway openings, pits and/or control room, as constructed, verify all critical dimensions, and examine supporting structures and all other conditions under which elevator work is to be installed. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 INSTALLATION

A. Install elevator systems components and coordinate installation of hoistway wall construction.
   1. Work shall be performed by competent elevator installation personnel in accordance with ASME A17.1, manufacturer's installation instructions and approved shop drawings.
   2. Comply with the National Electrical Code for electrical work required during installation.

B. Perform work with competent, skilled workmen under the direct control and supervision of the elevator manufacturer's experienced foreman.

C. Supply in ample time for installation by other trades, inserts, anchors, bearing plates, brackets, supports, and bracing including all setting templates and diagrams for placement.

D. Welded construction: Provide welded connections for installation of elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualification of welding operators.

E. Coordination: Coordinate elevator work with the work of other trades, for proper time and sequence to avoid construction delays. Use benchmarks, lines, and levels designated by the Contractor, to ensure dimensional coordination of the work.

F. Install machinery, guides, controls, car and all equipment and accessories to provide a quiet, smoothly operating installation, free from side sway, oscillation or vibration.

G. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum safe, workable dimensions at each landing.

H. Erect hoistway sills, headers, and frames before erection of rough walls and doors; erect fascia and toe guards after rough walls finished. Set sill units accurately aligned and slightly above finish floor at landings.

I. Lubricate operating parts of system, where recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

A. Acceptance testing: Upon completion of the elevator installation and before permitting use of elevator, perform acceptance tests as required and recommended by Code and governing regulations or agencies. Perform other tests, if any, as required by governing regulations or agencies.

B. Advise Owner, Contractor, Architect, and governing authorities in advance of dates and times tests are to be performed on the elevator.

3.04 ADJUSTING

A. Make necessary adjustments of operating devices and equipment to ensure elevator operates smoothly and accurately.

3.05 CLEANING

A. Before final acceptance, remove protection from finished surfaces and clean and polish surfaces in accordance with manufacturer's recommendations for type of material and finish provided. Stainless steel shall be cleaned with soap and water and dried with a non-abrasive surface; it shall not be cleaned with bleach-based cleansers.

B. At completion of elevator work, remove tools, equipment, and surplus materials from site. Clean equipment rooms and hoistway. Remove trash and debris.

1. Use environmentally preferable and low VOC emitting cleaners for each application type. Cleaners that contain solvents, pine and/or citrus oils are not permitted.

3.06 PROTECTION

A. At time of Substantial Completion of elevator work, or portion thereof, provide suitable protective coverings, barriers, devices, signs, or other such methods or procedures to protect elevator work from damage or deterioration. Maintain protective measures throughout remainder of construction period.

3.07 DEMONSTRATION

A. Instruct Owner's personnel in proper use, operations, and daily maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at time of failure in operation and other building emergencies. Train Owner's personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions.

B. Make a final check of each elevator operation, with Owner's personnel present, immediately before date of substantial completion. Determine that control systems and operating devices are functioning properly.

3.08 ELEVATOR SCHEDULE

A. Elevator Qty. 1
   1. Elevator Model: endura MRL Twinpost above-ground 2-stage
   2. Elevator Type: Hydraulic Machine Room-Less, Passenger
   3. Rated Capacity: 5000 lbs.
   4. Rated Speed: 80 ft./min.
   5. Operation System: TAC32H
   6. Travel: 15'-6"
   7. Landings: 2 total
   8. Openings:
      a. Front: 2
      b. Rear: 0
   9. Clear Car Inside: 5'-8" wide x 8'-5" deep
   10. Inside clear height: 7'-4" standard
   11. Door clear height: 7'-0" standard
   12. Hoistway Entrance Size: 4'-0" wide x 7'-0" high
   13. Door Type: Two-speed | LH Side opening
   14. Power Characteristics: 460 volts, 3 Phase, 60 Hz.
   15. Seismic Requirements: Zone
   16. Hoistway Dimensions: 7'-4" wide x 10'-2" deep
   17. Pit Depth: 4'-0"

18. Button & Fixture Style: Traditional Signal Fixtures
19. Special Operations: None
20. Digital Services:
    Remote Monitoring with Application Programming Interface (API) Integration

    ADA Phone - Code Compliant Cellular Connectivity

    A17.1 2019 Code - Enhanced Communications

    Smart Device Elevator Calling with occupant app API integration

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 21 of the Specifications and Drawings numbered with prefixes F, FP, or FS generally describe these systems, but the scope of the Fire Suppression work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general location and arrangement of the equipment, piping, etc. without showing all the exact details as to elevations, offsets, pipe routing, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
4. Division 21 Section 210533 “Heat Tracing for Fire-Suppression Piping” for heat tracing requirements.
5. Division 21 Section 210553 “Identification for Fire Suppression Piping and Equipment” for labeling and identification of installed fire suppression equipment.

6. Division 21 Section 211100 “Fire Suppression Water Service Piping” for fire suppression piping starting 5 feet outside the building to within the building.

7. Division 21 Section 211313 "Water-Based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.02 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer’s requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.

G. Regulatory Requirements: Comply with all standards listed in Section 1.2 and all applicable local requirements.

H. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section,{Division 26} {Division 28}

I. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.03 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the submission of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.

1. NFPA (National Fire Protection Association) 13, “Installation of Sprinkler Systems”, 20xx Edition.
2. NFPA 24, “Private Fire Service Mains and their Appurtenances”, 20xx Edition.
3. International Building Code (IBC), 20xx Edition with local amendments.
4. International Fire Code (IFC), Edition with local amendments.
5. Underwriters Laboratories, “Fire Protection Equipment Directory”, Latest Edition.

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Fire Suppression work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Fire Suppression work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”

2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”

3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.” When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a) Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b) Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve

the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

D. Other definitions for fire protection systems are listed in NFPA Standards.

E. Working Plans, also referred to as Fire Protection Drawings as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the Authority Having Jurisdiction.

F. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
3. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.05 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.

C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Fire Suppression systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect/Engineer. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

E. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire protection system shall include, but not be limited to:

1. Sprinkler monitoring equipment (water flow switches, valve tampers, etc) shall be provided by the fire sprinkler installer, but wired and connected by Division 28.

F. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and described within the specification sections.

1.06 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.

2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.

3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.

4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.

6. Indicate required installation sequence to minimize conflicts between entities.

7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.08 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks or time specified in the Engineer's Agreement with the Client for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section.

General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. Provide shop drawings prepared in accordance with referenced standards identified as "Working Plans", including hydraulic calculations where applicable. Shop drawings shall be developed by minimum NICET Level III technician. Submit copies of the certification for the designer with submittal. Shop drawings consisting of the following shall be furnished at a minimum. Refer to NFPA 13 for additional requirements.

1. Scaled site plan indicating underground piping with sizes and hydrants utilized for flow test in relation to the building.
2. Layout drawings of complete fire sprinkler system indicating relationship to all other trades. This shall include all equipment, piping and a reflected ceiling plan indicating sprinkler locations.
3. Complete details and sections as required to clearly define and clarify the design indicated.
4. Shop drawings shall be to a standard scale and not less than 3/32" = 1’-0".
5. Hydraulic calculations shall be based on a water flow test conducted at the site within twelve (12) months of the submittal of plans for approval. The contractor shall be responsible for obtaining the flow test if existing data is not provided in contract documents. Flow test information shall be documented on shop drawings with an accompanying site plan to scale. Contractor shall verify with AHJ any minimum safety factor requirements. Demand shall not be less than 5 psi below the supply at the demand point.
    a) Hydrant testing shall be in accordance with NFPA 13 and 291 requirements.
6. Available fire-hydrant flow test records indicate the following conditions:
    a) Date: 3/18/2025
    b) Performed by: Bentonville Water Utilities
    c) Location of Residual Fire Hydrant: hydrant 0783
    d) Location of Flow Fire Hydrant: hydrant 1784
    e) Static Pressure at Residual Fire Hydrant: 80
    f) Measured Flow at Flow Fire Hydrant: 2223
    g) Residual Pressure at Residual Fire Hydrant: 70

N. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval. Shop drawings showing deviations from the design without prior approval will not be approved.

O. Provide Test Reports and Certificates including:
1. "Contractor's Material & Test Certificate for Aboveground Piping"
2. "Contractor's Material & Test Certificate for Underground Piping" as described in NFPA
    a) Underground piping test certificate shall be obtained prior to connection of the aboveground system.

P. Provide welders’ qualification certificates.

Q. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.

1.09 ELECTRONIC DRAWING FILES

A. Contractor may request an electronic version of the contract drawing set in AutoCAD format from the Engineer for a fee of $250. Contact the Architect for written authorization. Contact the Engineer for the release agreement form and specify the shipping method and drawing format. Allow up to ten (10) working days for electronic file delivery after authorization and release agreements are completed and delivered to the Engineer.

1.10 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    a) Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b) Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c) Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d) Same warranty will be furnished for proposed substitution as for specified Work.
    e) If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f) Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion for the project, furnish to the Architect, for Engineer’s review,and for Owner’s use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Include the following sections with the appropriate information for each section:

1. Typewritten Index.

2. Qualifications. Provide designer and installer qualification.

3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.

4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.

5. Product Data: Provide product cut-sheets for all equipment utilized and installed.

6. Guarantee. Copy of all guarantees and warranties issued.

7. Testing/Certification: Provide all completed testing and certification forms as required per NFPA 13 and 25.

8. Contact list with minimum three service representative phone numbers.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 21 specifications.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall provide, at their expense, two reproducible copies of the final record of completion documents, final shop drawings, and as-builts of the fire sprinkler system. Each sheet shall be marked "Record Drawing", along with the date. One set of final drawings shall be placed into a Documentation Cabinet located adjacent to the water entry location, sized to contain all necessary documentation. A second set shall be delivered to the Architect/Engineer.

D. The fire shop drawings and all information contained therein shall be utilized as the basis for the Record Drawings.

1.14 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in a format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Fire Suppression Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Furnish service and maintenance of fire protection system for one year from date of substantial completion.

C. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The

Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

D. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Proper sloping of pipe to drain in each piping system per NFPA 13.

E. The above guarantees shall include labor (including travel expenses), troubleshooting and material; and repairs or replacements shall be made without additional cost to the Owner.

F. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

G. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed and stating the commencement date and term.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

3. Use of explosives is not permitted.

B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.01 GENERAL

A. Electrical Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Fire Suppression Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Fire Suppression Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections.

C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

D. Refer to Division 28, "Fire Detection and Alarm" for specification of sprinkler monitoring equipment connections.

E. All fire protection equipment shall be UL listed and FM Global approved (FM Global Insureds only) for its intended use and in conformance with the applicable NFPA codes.

F. System Pressures: All system components shall be listed for the actual designed system pressures.

1. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

2. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.

2.02 SOIL MATERIALS

A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.

C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall install, and test all new equipment identified in this contract and revise existing equipment as noted.

B. Installation shall be in accordance with NFPA requirements and the Contractor shall have employed or enlist the design services of at least one minimum NICET Level II certified technician.

C. Installer: Company specializing in the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire sprinkler submittal proof of factory training for each installer.

D. The Contractor shall provide all required equipment, sprinklers and piping for a complete and operational fire protection system. All components shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

E. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

3.02 PERMITS

A. Secure and pay for permits required in connection with the installation of the Fire Suppression Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.03 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Section.

B. Report test results promptly and in writing.

3.04 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.05 EXCAVATION AND BACKFILLING

A. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.

B. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

C. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

D. The Contractor shall erect barricades around excavations, for safety, and shall place an adequate number of amber lights on or near the work and shall keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

E. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

F. Install sediment and erosion control measures in accordance with local codes and ordinances.

G. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

H. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

I. Trenching: Excavate trenches for Fire Suppression installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.

5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

   a) For pipes or equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom 1/4 of the circumference. Fill unevenness with tamped sand backfill. At each pipe joint over-excavate to relieve the bell or pipe joint of the pipe of loads, and to ensure continuous bearing of the pipe barrel on the bearing surface.

J. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

K. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of piping, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas, use excavated or borrowed materials.

L. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

M. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

N. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

O. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

P. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a) Areas under structures, building slabs, steps, and pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

b) Areas under walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

c) Other areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

Q. Subsidence: Where subsidence occurs at Fire Suppression installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.06 CUTTING AND PATCHING

A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.

B. No structural member shall be cut without permission from Architect and Structural Engineer.

C. Patch around openings to match adjacent construction.

D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.07 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Fire Suppression Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Fire Suppression Contractor shall clean material and equipment installed under the Fire Suppression Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.08 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, they shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare an "observation list" of items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. Cotshall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance ☐ Yes ☐ No

Additional Comments: ☐ Attached ☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with Fire Suppression installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to Fire Suppression materials and equipment.
2. Concrete for bases and housekeeping pads.
3. Non-shrink grout for equipment installations.
4. Miscellaneous metals for support of Fire Suppression materials and equipment.
5. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Fire Suppression materials and equipment.
6. Joint sealers for sealing around Fire Suppression materials and equipment.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 21 Section 210010 “General Fire Suppression Requirements” for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
3. Division 21 Section 210515 "Basic Fire Suppression Piping Methods and Materials," for general piping and fitting materials and methods.
4. Division 21 Section 210553 “Identification for Fire Suppression Piping and Equipment” for labeling and identification of installed fire suppression equipment.
5. Division 21 Section 211100 “Fire Suppression Water Service Piping” for fire suppression piping starting 5 feet outside the building to within the building.
6. Division 21 Section 211313 "Water-Based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 21 Section “General Fire Suppression Requirements”.

1. Product data for the following products:

a) Access panels and doors.

b) Through and membrane-penetration firestopping systems.

2. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

a) Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

1.03 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

PART 2 - PRODUCTS

2.01 ACCESS TO EQUIPMENT

A. Acceptable Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section “Identification for Fire Suppression Piping and Equipment” for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.

4. The exact location of all access doors shall be verified with the Architect prior to installation.

5. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

    a) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.

    b) For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.

    c) For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

6. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

    a) Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

7. Locking Devices: Flush, screwdriver-operated cam locks.

2.02 FIRE SUPPRESSION EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated Fire Suppression equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.03 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.04 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall

be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

1. Framing materials shall be fire resistant treated for use in Type I and II buildings.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

1. Framing materials shall be fire resistant treated for use in Type I and II buildings.

2.05 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

a) "Dow Corning 790," Dow Corning Corp.

b) "Silglaze II SCS 2801," General Electric Co.

c) "Silpruf SCS 2000," General Electric Co.

d) "864," Pecora Corp.

e) "Rhodia 5C," Rhone-Poulenc, Inc.

f) "Spectrem 1," Tremco, Inc.

g) "Spectrem 2," Tremco, Inc.

h) "Dow Corning 795," Dow Corning Corp.

i) "Rhodia 7B," Rhone-Poulenc, Inc.

j) "Rhodia 7S," Rhone-Poulenc, Inc.

k) "Omniseal," Sonneborn Building Products Div.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

a) "Dow Corning 786," Dow Corning Corp.

b) "Sanitary 1700," General Electric Co.

c) "898 Silicone Sanitary Sealant," Pecora Corp.

d) "OmniPlus," Sonneborn Building Products Div.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Products: Subject to compliance with requirements, provide one of the following:

a) "Chem-Calk 600," Bostik Construction Products Div.

b) "AC-20," Pecora Corp.

c) "Sonolac," Sonneborn Building Products Div.

d) "Tremflex 834," Tremco, Inc.

2.06 ACOUSTICAL SEALANTS

A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

PART 3 - EXECUTION

3.01 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.02 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Fire Suppression materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.03 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Fire Suppression materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.04 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.05 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.06 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

I. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

J. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 21 Section “Basic Fire Suppression Piping Materials and Methods

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 21 and includes piping, joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 21 Section 210010 “General Fire Suppression Requirements” for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
3. Division 21 Section 210553 “Identification for Fire Suppression Piping and Equipment” for labeling and identification of installed fire suppression equipment.
4. Division 21 Section 211100 “Fire Suppression Water Service Piping” for fire suppression piping starting 5 feet outside the building to within the building.
5. Division 21 Section 211313 "Water-Based Fire Suppression Systems" for fire-suppression sprinkler systems inside the building.

1.02 SUBMITTALS

A. Refer to Division 1 and Division 21 “General Fire Suppression Requirements” for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Piping and Fittings
2. Escutcheons
3. Dielectric Unions and Fittings
4. Sleeves and Mechanical Sleeve Seals
5. Wall Pipes

1.03 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

C. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.

D. UL and FM Global Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved (FM Global Insureds only) for fire service.

E. Pipe, piping specialties and fittings shall be manufactured in plants located in the United States.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. All fire suppression system materials and components essential to successful system operation shall be listed for their intended purpose.

B. Fire suppression system materials and components shall be UL Listed

C. General: Refer to the individual piping system specification sections in Division 21 for specifications on piping and fittings relative to that particular system.

2.02 STEEL PIPE AND FITTINGS

A. All piping 2-inch and smaller:

1. With the use of welded or roll grooved fittings: ASTM A135 or 795, Grade A, Schedule 10 or 40, seamless or ERW, black steel pipe.
2. With the use of threaded fittings: ASTM A135 or 795, Grade A, Schedule 40, seamless or ERW, black steel pipe.

B. All piping 2-1/2" and larger: ASTM A135 or 795, Grade A, Schedule 10, ERW, black steel pipe, roll grooved ends.

C. Piping used in dry pipe and preaction sprinkler systems shall be ASTM A135 or 795, Type E, Grade A, Schedule 40, black steel pipe, threaded or roll grooved ends.

D. Galvanized piping including fittings is not permitted.

E. All piping on the exterior and/or interior corrosive environment, exterior, and interior corrosive environment of the building shall be externally painted red in color by one of the following methods:

1. Field painting using urethane alkyd paint.
2. Powder coat.

3. Polymer enhanced coated.

4. Galvanized and painted where in interior corrosive environment.

F. Acceptable alternatives to Schedule 40 and Schedule 10 pipe shall be manufactured to standards recognized by NFPA 13. Threaded pipe shall have a corrosion resistance rating (CRR) of 1.0 or greater. Crimp type couplings shall not be used. Threadable thinwall pipe with CRR less than 1.0 not permitted.

G. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

H. Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

I. Steel Couplings: ASTM A 865, threaded

J. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

K. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

L. Malleable- or Ductile-Iron Unions: UL 860.

M. Cast-Iron Flanges: ASME 16.1, Class 125.

N. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

O. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

P. Grooved-Joint, Steel-Pipe Appurtenances

1. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

2. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

3. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

2.03 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.04 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.05 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM Global approved.

2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.

B. Check Valves:

1. Description: Swing-check type, rubber-face checks unless otherwise indicated, and ends matching piping.

2. Standard: UL 312.

3. Pressure Rating: 250 psig minimum.

4. Type: Swing check.

5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:

1. Description: Bronze body and bonnet and bronze stem.
2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded or grooved.

D. Iron OS&Y Gate Valves:

1. Description: Iron body and bonnet and bronze seating material.
2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:
   a) Valve Type: Ball or butterfly.
   b) Body Material: Bronze.
   c) End Connections: Threaded or grooved.
4. Valves NPS 2-1/2 and Larger:
   a) Valve Type: Butterfly.
   b) Body Material: Cast or ductile iron.
   c) End Connections: Flanged or grooved.
5. Valve Operation: Integral, prewired supervisory switch and visual indicating device.

2.06 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing (FM Global insureds only).
2. Pressure Rating: 175 psig minimum.

B. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.07 AUTOMATIC AIR RELEASE VALVE

A. Standard: UL 2573

B. Pressure Rating: 175 psig minimum.

2.08 FIRE-DEPARTMENT CONNECTIONS

A. Storz-Type, Fire-Department Connection:

1. Pressure Rating: 175 psig minimum.
2. Body Material: Aluminum Alloy.
3. Inlets: NPS 5 inch. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
4. Caps: Aluminum with gasket and chain.
5. Escutcheon Plate: Rectangular, brass, wall type.
6. Outlet: NPS 4 inch
7. Escutcheon Plate Marking: Similar to AUTO SPKR
8. Include 30 degree downturn elbow.
9. Finish: Anodized aluminum

2.09 PIPING SPECIALTIES

A. Escutcheons: Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

1. One-Piece, Cast-Brass Type: With chrome plated finish and setscrew fastener.
2. One-Piece, Stamped-Steel Type: With white painted finish and spring-clip fasteners.
3. Split-Casting Brass Type: With chrome plated [Polished chrome plated][Rough brass] finish and with concealed hinge and setscrew.
4. Split-Plate, Stamped-Steel Type: With white painted finish, concealed hinge, and spring-clip fasteners.

B. Floor Plates: Inside diameter shall closely fit pipe outside diameter. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

1. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

2. Split-Casting Floor Plates: Cast brass with concealed hinge.

C. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

D. Dielectric Unions and Fittings: Provide factory-fabricated dielectric unions and fittings with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

E. Pressure Gauges

1. Standard: UL 393.

2. Dial Size: 3-1/2- to 4-1/2-inch diameter.

3. Pressure Gage Range: 0 to 300 psig.

4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

5. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

2.10 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

3. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

4. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect

before installing any box openings not shown on the Architectural or Structural Drawings.

B. Wall Pipes

1. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.

a) Underdeck Clamp: Clamping ring with setscrews.

C. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

a) Pressure Plates: Carbon steel or stainless steel.

b) Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

C. Painting of fire sprinkler painting:

1. Field painting of fire sprinkler piping per manufacturer's published instructions and include a minimum of one-coat of rust inhibited primer and two-coats of urethane alkyd.

2. Powder coating per manufacturer's published instructions.

3. Polymer enchanced coating per manufacturer's published instructions.

3.02 PIPING INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Coordinate installation of horizontal piping with other components. Allow sufficient space above removable ceiling panels to allow for panel removal (minimum 6” clearance).

C. Install system such that all piping is rigidly secured and supported. All ductwork, lights, structural members and main runs of piping shall take precedence over sprinkler piping. Cutting of structural members for passage of sprinkler pipes or hangers shall not be permitted. All horizontal piping in ceiling space shall be at an elevation above the top of light fixtures and air outlets to allow for access to light fixtures and air outlets without removing horizontal piping. Route all sprinkler piping and provide all offsets, bends, and elbows around all mechanical, electrical, and structural members as required.

D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise. In areas with ceilings, piping shall be routed concealed, above ceiling. In areas without ceilings, piping shall extend as high as possible.

E. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

F. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install sprinkler piping to provide for system drainage in accordance with NFPA 13. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.

J. Coordinate pipe routing near electrical equipment in accordance with NFPA 70.

K. Verify final equipment locations for roughing in.

L. Deviations from approved "Working Plans" for sprinkler piping require written approval of the Authority Having Jurisdiction. Written approval shall be on file with the Engineer prior to deviating from the approved "Working Plans."

M. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

C. Install unions in pipes NPS 2 and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.

D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

E. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems.

F. Non-ferrous Pipe Joints:

1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

a) Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

H. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads and Pipe Fitter's Handbook. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads that are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

I. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to

ASME B31.9. Align flanged surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

J. Mechanical Grooved Joints: Roll grooves on pipe ends dimensionally compatible with the couplings. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Joints for other piping materials are specified within the respective piping system sections.

3.04 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connection.

B. Install connections between 18- and 36-inches above finished grade and as indicated on the Drawings.

C. Grout or caulk pipe penetration in exterior wall.

D. Provide minimum 36-inch working clearance around connection for fire department access.

E. Install automatic (ball drip) drain valve at each check valve for fire department connection. .

3.05 ALARM DEVICE INSTALLATION

A. General: Comply with NFPA 24 for devices and methods of valve supervision.

B. Supervisory Switches: Supervise valves in open position unless noted otherwise.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.

2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.

2. Post Indicators: Install padlock on wrench on indicator post.

D. Water-Flow Indicators: Install in fire suppression piping where indicated. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

E. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Division 28 Sections.

3.06 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at the end of each day or whenever work stops.

3.07 PENETRATIONS

A. Fire suppression penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

   a) Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

   b) Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

   c) Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

      1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

      2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

   d) Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

C. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.

2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."

5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

F. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

2. Provide 1/2-inch thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2-inch above and below the concrete slab.

G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of sealant. Refer to Division 21 Section "Common Work Results for Fire Suppression" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.

H. Exterior Wall Penetrations: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.

I. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 21 Section "Common Work Results for Fire Suppression" for firestopping and materials.

3.08 ACOUSTICAL PENETRATIONS

A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the Fire Suppression equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.

B. Fire Sprinkler Piping

1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

3.09 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Extent of Fire Suppression work to be identified as required by this Section is indicated on drawings and/or specified in other Division 21 Sections.

B. Types of identification devices specified in this Section include the following:

1. Equipment labels.
2. Valve tags.
3. Hydraulic placards.

C. Related Sections

1. Division 21 Section 210010 “General Fire Suppression Requirements” for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.
2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
4. Division 21 Section 211100 "Fire Suppression Water Service Piping," for fire suppression piping starting 5 feet outside the building to within the building.
5. Division 21 Section 211313 "Water Based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.02 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, aluminum, or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Background/Letter Color: Red/White or Bare Metal/Black.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Background/Letter Color: Red/White
3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number,

2.02 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, stainless steel, aluminum or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain, beaded chain or S-hook.
3. Valve-Tag Color: Red.
4. Letter Color: White.

2.03 HYDRAULIC PLACARDS

A. Provide hydraulic calculation placard attached to each riser in accordance with NFPA 13. Placard shall include location of design area or areas, discharge densities over the design area or areas, required flow and pressures at the base of riser, occupancy classification and maximum permitted storage height and configuration, hose stream allowance included in addition to the sprinkler demand and name of installing contractor. Information shall be permanently and clearly displayed on placard.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT IDENTIFICATION

A. General: Install metal or plastic equipment marker on or near each major item of fire protection equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
1. Pumps
2. Tanks and pressure vessels
3. Backflow Preventers

3.03 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire suppression systems

3.04 LABEL INSTALLATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install or permanently fasten labels on each major piece of equipment.

D. Locate equipment labels where accessible and visible.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. The extent of this fire suppression water service piping shall be as specified herein. Contractor shall be responsible for preparation of design drawings, fabrication and installation for complete fire suppression water service piping for the building.

B. This section specifies:

1. Materials and equipment for fire suppression water service piping and related components starting 5-feet outside the building and the following:

a) Service entrance piping through floor into the building.

C. This section includes:

1. Pipe and fittings
2. Valves
3. Post indicating valves
4. Backflow preventers
5. Alarm devices
6. Accessories

D. Provide facility fire suppression water service piping during construction in accordance with code.

E. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 21 Specifications Sections, apply to this section.

F. Related Sections:

1. Division 31 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.
2. Division 33 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building and extending to the water service line.
3. Division 21 Section 210010 “General Fire Suppression Requirements” for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.
4. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.

5. Division 21 Section 210553 “Identification for Fire Suppression Piping and Equipment” for labeling and identification of installed fire suppression equipment.

6. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.02 SUBMITTALS

A. Submit shop drawings prepared in accordance with Division 21 Section 210010 “General Fire Suppression Requirements.”

1.03 QUALITY ASSURANCE

A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of the Facility Fire Suppression Water Service Piping.

B. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for fire suppression water service piping, including materials, hose threads, installation, and testing.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

D. NFPA 24, “Private Fire Service Mains and their Appurtenances”, Latest Edition. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire suppression water service piping.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.

3. Set valves in best position for handling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.05 PROJECT CONDITIONS

A. Interruption of Existing Fire Suppression Water Service Piping: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water distribution service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven (7) days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without written permission from Architect, Construction Manager, or Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Division 21 Section 210515 “Basic Fire Suppression Piping Materials and Methods” for general piping fittings and piping specialty requirements.

2.02 DUCTILE-IRON PIPE AND FITTINGS.

A. Mechanical-Joint, Cement Lined Ductile-Iron Pipe: AWWA C151/C104, with mechanical-joint bell and plain spigot end.

B. Mechanical-Joint, Cement Lined Ductile-Iron Fittings: AWWA C110/C104, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Flanges: ASME B16.1, Class 125, cast iron.

D. Ductile-Iron Deflection Fittings:

1. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2. Pressure Rating: 250 psig minimum.

2.03 SERVICE ENTRANCE ASSEMBLY

A. At Contractor's option, the service entrance is permitted to utilize a one-piece riser assembly to enter the building.

1. Assembly shall be Ames Fire and Waterworks Series IBR or approved equivalent. In-Building Riser shall be composed of a single extended 90 degree fitting of fabricated 304 stainless steel tubing, maximum working pressure 200 psi. The fitting shall have a grooved-end connection on the outlet (building) side and a CIPS coupler on the inlet (underground) side. The grooved end shall include a coupler and cap to facilitate testing of the underground piping.

2.04 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: Linear low-density PE film of 0.008-inch (0.20-mm) or High-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

C. Form: Sheet or tube.

2.05 CURB VALVES

A. Curb Valves: Comply with AWWA C800 for high pressure service line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.

B. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.

1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.06 GATE VALVES

A. UL Listed or FM Approved Gate Valves:

1. UL listed or FM approved, Iron, Non-rising Stem Gate Valves:

a) Description: Iron body and bonnet, bronze seating material, and inside screw.

b) Standards: UL 262 listing and "Approval Guide," published by FM Global, approval.

c) Pressure Rating: 175 psig minimum.

d) End Connections: Mechanical or push-on joint.

e) Indicator-Post Flange: Include on valves used with indicator posts.

2. UL-Listed or FM-Approved, Iron, OS&Y, Gate Valves:

a) Description: Iron body and bonnet and bronze seating material.

b) Standards: UL 262 listing and "Approval Guide," published by FM Global, approval.

c) Pressure Rating:175 psig minimum.

d) End Connections: Flanged or grooved.

2.07 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5-inches (125 mm) in diameter.

1. Operating Wrenches: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

B. Indicator Posts:

1. Description: Vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2. Standards: UL 789 listing and "Approval Guide," published by FM Global, approval.

2.08 CHECK VALVES

A. UL listed or FM approved Check Valves:

1. Description: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.

2. Standards: UL 312 listing and "Approval Guide," published by FM Global, approval.

3. Pressure Rating: 175 psig minimum.

2.09 BACKFLOW PREVENTERS

A. Double Check Backflow Preventer Assembly:

1. Standard: ASSE 1015.

2. Operation: Continuous-pressure applications unless otherwise indicated.

3. Body Material: Cast iron with fused epoxy coating or stainless steel.

4. End Connections: Threaded, Flanged, or Grooved.

5. Accessories: Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.

B. Double Check Detector Backflow Preventer Assembly:

1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.

2. Operation: Continuous-pressure applications.

3. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved; Steel with interior lining complying with AWWA C550 or that is FDA approved; or Stainless steel.

4. End Connections: Threaded, Flanged, or Grooved.

5. Accessories:

a) Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.

b) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.02 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated elevation.

C. Pipe Beds:

1. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation. Provide first layer of pea gravel backfill 6-inch above pipe, tamp backfill with mechanical tamper to 85% to 95% compaction. For

piping with rock trench bottoms, provide sand pipe bed 6-inch underneath and around sides of pipe up to middle half of the pipe, including fittings.

D. Provide backfill above top of pipe bed as required for field conditions. Refer to Division 21 Section 210010 "General Fire Suppression Requirements" for materials and methods for backfill.

3.03 PIPE APPLICATIONS

A. Piping below grade: Provide cement lined ductile iron pipe and fittings with mechanical joints.

3.04 PIPING INSTALLATION

A. Comply with NFPA 24 for fire service main piping materials and installation.

B. Water main connection: Arrange with water utility company for tap of size and in location indicated in water main or tap water main according to the requirements of the water utility company.

C. Install ductile-iron, water service piping according to AWWA C600 and AWWA M41.

1. Install encasement for piping according to ASTM A 674 or AWWA C105.

D. Bury piping with depth of cover over top of piping at least 30-inches, with top at least 12-inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36-inches of cover over top.
2. Under Railroad Tracks: With at least 48-inches of cover over top.

E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

F. Extend fire suppression water service piping and connect to water supply source and building fire suppression water service piping systems at locations and pipe sizes indicated.

1. Terminate fire suppression water service piping at building floor slab until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire suppression water service piping systems when those systems are installed.

G. Do not extend water service piping more than 10 ft under building floor slab.

H. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

I. Comply with requirements in Section 211313 "Water-Based Fire Suppression Systems" for fire suppression water piping inside the building.

J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210515 "Basic Fire Suppression Piping Materials and Methods."

3.05 JOINT CONSTRUCTION

A. See Division 21 Section 210515 “Basic Fire Suppression Piping Materials and Methods” for general joint construction requirements.

B. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.

C. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.

D. Ductile-Iron Piping, Gasketed-Joints for Fire Service Main Piping: UL 194.

E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.

3.06 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Locking mechanical joints.
2. Bolted flanged joints.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire suppression water service piping according to NFPA 24 and the following:

1. Gasketed-Joint, Ductile-Iron, Water Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.07 VALVE INSTALLATION

A. See Division 21 Section 210515 “Basic Fire Suppression Piping Materials and Methods” for general valve installation requirements.

B. UL-Listed or FM-Approved Gate Valves: Comply with NFPA 24. Install each underground valve(s) in vaults and with vertical cast-iron indicator post.

C. UL-Listed or FM-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

D. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Division 03.

3.08 BACKFLOW PREVENTER INSTALLATIONS

A. Install backflow preventer at each fire protection entry in compliance with the plumbing code and Authority Having Jurisdiction. Locate in an accessible and testable location.

B. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers with pipe supports attached to the floor with anchor bolts where indicated on the drawings.

E. Test backflow preventer per requirements of plumbing or division of cross connection control official.

1. Reports: Prepare backflow preventer test reports signed by the plumbing or division of cross connection control official and turn over to the Architect upon completion of the project.

3.09 POST INDICATOR VALVE

A. Install post indicator valve on the underground supply as indicated on the Drawings. Post indicator valve shall be electronically supervised-open.

3.10 FIELD QUALITY CONTROL

A. Flush, test, and inspect in accordance with NFPA 24.

B. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.

1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.11 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground fire suppression water service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.12 CLEANING

A. Clean fire suppression water service piping as follows:

1. Flush new piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use flushing procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

B. Prepare reports of flushing activities.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. The extent of this fire sprinkler system shall be as specified herein. Contractor shall be responsible for preparation of design drawings, hydraulic calculations, fabrication and installation for complete fire sprinkler protection for the building.

B. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire protection valves.
3. Sprinkler pipe fittings.
4. Sprinklers.
5. Alarm devices.
6. Control panels.

C. Related Sections:

1. Division 21 Section 210010 “General Fire Suppression Requirements” for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
4. Division 21 Section 210553 “Identification for Fire Suppression Piping and Equipment” for labeling and identification of installed fire suppression equipment.
5. Division 21 Section 211100 “Fire Suppression Water Service Piping” for fire suppression piping starting 5 feet outside the building to within the building.

1.02 SYSTEM DESCRIPTION

A. Fire protection system in the location or portion of the building consists of wet pipe and dry pipe systems.

1. Wet Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to a water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts a fusible link or destroys a frangible device. Hose connections are included if indicated.

2. Dry Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open a dry pipe valve. Water then flows into piping and discharges from sprinklers that are open.

B. Provide system(s) as specified herein and as shown on drawings. The sprinkler system shall be supplied by the underground or fire suppression standpipe system as shown on the Drawings.

C. Provide dry pipe fire protection system for non-heated spaces and other areas of building subject to freezing including the loading docks and canopies, mansards, and balconies. Portions of systems subject to freezing or temperatures below 40° F shall be protected against freezing as required by NFPA 13. The Contractor shall be responsible for repairs and for all costs incurred from damage caused by freezing of the fire protection system.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design fire suppression system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Standard Pressure, Fire Suppression System Component: Listed for 175-psig minimum working pressure.

C. Performance Criteria

1. Protect entire building/area of work, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Light Hazard requirements.
2. Protect mechanical and electrical areas/rooms with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 1 requirements.
3. Protect storage areas/rooms, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 2 requirement.
4. Other Occupancy Hazard Classifications.
    a) Building Service Areas: Ordinary Hazard Group 1.
    b) Office and Public Areas: Light Hazard.
    c) Restaurant Seating Areas: Light Hazard.
5. Design Criteria for Automatic-Sprinkler Piping Design:
    a) Light Hazard Occupancy:
        1) Minimum Design Density: 0.10 gpm over 1,500 sq.ft. area.
        2) Maximum protection area per sprinkler: 225 sq.ft.

3) Minimum Combined Hose Stream Demand Requirement: 100 gpm for 30 minutes.

b) Ordinary Hazard Group 1 Occupancy:

1) Minimum Design Density: 0.15 gpm over 1,500 sq.ft. area.

2) Maximum area per sprinkler: 130 sq.ft..

3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.

c) Ordinary Hazard Group 2 Occupancy:

1) Minimum Design Density: 0.20 gpm over 1,500 sq.ft. area.

2) Maximum protection area per sprinkler: 130 sq.ft.

3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.

D. The criteria listed herein shall not preclude the use of extended coverage or special application fire sprinklers designed and installed in accordance with their listing and manufacturer's instructions.

E. The hydraulic remote area of operation may not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers in unfinished shell spaces. For areas outside of the hydraulically remote area, the hydraulic area of operation shall not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers unless specifically approved by the Engineer via a formally submitted RFI.

F. Sprinkler spacing shall conform to NFPA 13 and shall not exceed 256 SF per sprinkler in unfinished shell spaces.

G. The hydraulic area of operation shall be increased by 30% without revising the density for areas with sloped ceilings with a pitch exceeding 1 in 6 (16.7% slope) in accordance with NFPA 13.

H. The hydraulic area of operation shall be increased by 30% without revising the density for dry-pipe and double interlock preaction systems in accordance with NFPA 13.

1.04 SUBMITTALS

A. Submit shop drawings prepared in accordance with NFPA 13 as specified in Division 21 Section 210010 "General Fire Suppression Requirements."

1.05 QUALITY ASSURANCE

A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of a fire sprinkler system.

B. Tests and Inspections: Arrange, test, and pay for all tests required by code and authorities having jurisdiction.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Fire Sprinkler Protection: Do not interrupt fire sprinkler system protection to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire sprinkler protection according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of fire-sprinkler protection.

2. Do not proceed with interruption of fire sprinkler protection with permission of the Architect.

1.07 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.08 EXTRA MATERIALS

A. Sprinkler Wrenches: Furnish to Owner, 2 sprinkler wrenches for each type of sprinkler installed.

B. Sprinklers: Furnish extra sprinklers of each style, type and finish included in the project as required by NFPA 13.

C. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet(s), suitable for wall mounting, with hinged cover and space for the quantity of spare sprinklers provided plus sprinkler wrench(es).

D. Provide hydraulic calculation placard attached to each riser.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. All fire protection equipment shall be UL Listed for its intended use and in conformance with the applicable NFPA documents.

2.02 PIPE AND FITTING MATERIALS

A. Refer to Division 21 Section 210515 “Basic Fire Suppression Piping Materials and Methods” for specifications on piping and fittings.

2.03 HANGERS

A. Shall be UL listed and shall meet requirements of NFPA 13 for type, dimension and location.

2.04 GENERAL DUTY VALVES

A. Refer to Division 21 Section 210515 “Basic Fire Suppression Piping Materials and Methods” for specifications on general duty valves.

2.05 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by Factory Mutual, approval.
2. Pressure Rating:
   a) Standard Pressure Piping Specialty Valves: 175-psig minimum.
   b) High Pressure Piping Specialty Valves: 250-psig minimum.
3. Body Material: Cast- or ductile- iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Dry-Pipe Valves:

1. Standard: UL 260.
2. Design: Differential-pressure type.
3. Include UL 1486, quick-opening devices, trim sets for bypass, air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, drip cup assembly piped with check valve to main drain piping, priming chamber attachment, and fill-line attachment with strainer.
4. Air-Pressure Maintenance Device:
   a) Type: Automatic device to maintain minimum air pressure in piping.
   b) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator

or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.

D. Nitrogen Generator:

1. Approved Manufacturers:
   a) Engineered Corrosion Services
   b) SouthTek
   c) Owner- and Engineer-approved Equal
2. Additional Equipment:
3. Air compressor
   a) Standard: UL's "Fire Protection Equipment Directory" listing.
   b) Power: 1/2 hp, 120-V ac, 60 Hz, single phase.
   c) Provide combination fused disconnect switch and magnetic starter.
4. Automatic oxygen/air purge system
5. Nitrogen purity monitor

E. Air Release Valve:

1. Provide for all wet pipe sprinkler systems at the highest accessible point of each sprinkler zone, using utilizing metallic piping in accordance with one of the following options:
   a) Manual ball valve with a minimum size of ½ inch (15 mm).
   b) UL Listed.

2.06 PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, welded or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.

2. Pressure Rating: 175-psig minimum.

3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

4. Size: Same as connected piping.

5. Inlet and Outlet: Grooved or threaded.

C. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.

2. Pressure Rating: 175-psig minimum.

3. Body Material: Cast- or ductile-iron housing with sight glass.

4. Size: Same as connected piping.

5. Inlet and Outlet: Threaded.

D. Flexible Piping Systems:

1. At Contractor’s option, UL listed and FM Global approved braided flexible piping connections to sprinklers may be used for both acoustical panel and gypsum board ceilings when suitable for their intended use. Piping shall be seismically qualified per ICC-ES AC-156 where required.

2. Description: Connections shall include a leak-tested sprinkler drop with a minimum internal corrugated hose diameter of 1 inch.

3. Flexible piping lengths shall not exceed 6 feet.

4. Installation shall not exceed the minimum bend radius and maximum allowable bends as specified by the manufacturer.

5. Change in direction shall be gradual enough to allow flexible piping to bend without crimping, distorting or reducing internal diameter.

2.07 AUTOMATIC SPRINKLERS

A. Sprinklers: type and style as indicated or required by application. Sprinkler operating temperatures to comply with NFPA 13. Sprinklers in Light Hazard areas shall be quick response type.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.

2. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

3. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Use sprinkler types below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Rooms with Gypsum Board Ceilings: Concealed sprinklers.
4. Wall Mounting: Sidewall sprinklers.
5. Spaces Subject to Freezing: Dry pendent or dry sidewall sprinklers as indicated on drawings.

E. Provide sprinkler types below with finishes indicated.
1. Finished Areas:
a) Concealed Sprinklers: Rough brass, with cover plate factory painted to match ceiling. Coordinate ceiling color with architect.
b) Recessed Sprinklers: Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
c) Upright, Pendent, and Sidewall Sprinklers: Recessed Sprinklers: Bright chrome, with bright chrome escutcheon
d) Unfinished Areas: Rough bronze in unfinished spaces not exposed to view.

F. Coordinate sprinkler temperature ratings near heat-producing sources in accordance with NFPA 13.

G. Sprinklers shall be wax coated or otherwise protected by manufacturer's coating where exposed to acids, chemicals, or other corrosive fumes.

H. Sprinkler Guards: Provide sprinkler guard where sprinklers are less than 7-feet above finished floor; where subject to physical damage, and/or where indicated on drawings. Guard shall be UL 199 listed.

I. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet, suitable for wall mounting, with hinged cover and space for the appropriate quantity of spare sprinklers plus sprinkler wrench(es).

2.08 ALARM DEVICES

A. General: Alarm device types shall match piping and equipment connections.

B. Audible/Visual Alarm Notification Appliances (Horn/Strobe):

1. Standard: UL 1971 combination horn and strobe appliance.
2. Horn: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.
3. Strobes: Strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch (25-mm) high letters on the lens.
4. Audible/visual notification appliance shall be exterior, weatherproof with weatherproof backbox.

C. Water Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory set, field-adjustable retard element to prevent false signals and tamperproof cover.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

D. Pressure Switches – Water Flow Alarm Detection:

1. Standard: UL 346.
2. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory set, field adjustable retard element to prevent false signals and tamperproof cover.
3. Type: Electrically supervised water flow switch with retard feature.
4. Pressure Rating: 250 psig.
5. Design Operation: Rising pressure signals water flow.

E. Pressure Switches – Low/High Air Pressure Supervisory:

1. Standard: UL 346.
2. Components: Two single-pole, double-throw circuit switches for isolated alarm contacts, 7 A, 125-V ac and 0.25 A, 24-V dc.
3. Type: Electrically supervised pressure supervisory switch
4. Pressure Rating: 250 psig.

5. Design Operation: Rising pressure signals excessive supervisory air pressure within the system piping, with lowering pressure signals lack of air pressure within the system piping.

F. Valve Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.

4. Design: Signals that controlled valve is in other than fully open position.

G. Indicator Post Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.

4. Design: Signals that controlled indicator post valve is in other than fully open position.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.02 PREPARATION

A. Perform fire hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

3.03 WATER SUPPLY CONNECTION

A. Connect sprinkler piping to water service piping for service entrance to building. Do not connect to underground supply until provided with written documentation that piping has been flushed and pressure tested in accordance with NFPA 13. Comply with requirements for exterior piping in Division 21 Section 211100 “Fire Suppression Water Service Piping."

B. Connect sprinkler piping to building's interior water distribution piping. Comply with requirements in Division 22 Section 221116 "Domestic Water Piping" for interior piping.

C. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section 211100 “Fire Suppression Water Service Piping."

D. Wet pipe systems shall be equipped with a listed relief valve not less than ½-inch in size and set to operate at 175 psi or 10 psi in excess of the maximum system pressure, whichever is greater.

3.04 PIPE APPLICATIONS

A. Piping Below Grade: Refer to Division 21 Section 211100 “Fire Suppression Water Service Piping.”

B. Piping Above Grade: Refer to Division 21 Section 210515 “Basis Fire Suppression Piping Materials and Methods.”

3.05 PIPING INSTALLATIONS

A. Refer to Division 21 Section 210515“Basic Fire Suppression Piping Materials and Methods” for general fire suppression piping installation requirements.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Hangers and Supports: Comply with the requirements of NFPA 13. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake if required by the applicable building code, designed in accordance with NFPA 13. Locate hangers at or directly adjacent to the joist panel points. Provide two nuts on threaded supports to securely fasten the support.

D. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.

E. Install pressure gauge on the riser or feed main at or near each test connection. Provide pressure gauge with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.

F. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

G. Drain dry-type sprinkler system piping.

H. Fill wet-type sprinkler system piping with water.

I. Connect nitrogen supply to dry pipe sprinkler piping.

J. Connect nitrogen source to the following piping and wiring:

1. Pressure gauges and controls.

2. Electrical power system.

3. Fire-alarm devices, including high- and low-pressure alarm.

K. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods"

L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods."

3.06 PIPE JOINT CONSTRUCTION

A. Refer to Division 21 Section 210515 “Basic Fire Suppression Piping Materials and Methods” for general pipe joint construction requirements.

3.07 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable water supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

2. Alarm Valves: Include bypass check valve and retarding chamber drain line connection.

3.08 SPRINKLER INSTALLATIONS

A. Use proper tools to prevent damage during installations.

B. Areas with ceilings: Install sprinklers not less than 6-inches from the edge of a ceiling tile in areas with suspended ceilings, in a symmetrical pattern with lights and outlets.

C. Install sprinklers in suspended ceilings in center or quarter point of acoustical ceiling panels, in a symmetrical pattern with lights and outlets.

D. Install sprinklers in a symmetrical pattern with lights and outlets in all other areas with ceilings.

E. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

F. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

G. Do not install more than one sprinkler on a one inch outlet unless hydraulic calculations are included to verify performance.

3.09 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and Division 21 Section 210553 “Identification for Fire Suppression Piping and Equipment.”

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform required tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, “Systems Acceptance” Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire alarm tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

C. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.13 COMMISSIONING

A. Sprinkler Systems: Test per NFPA 13, NFPA 25 and local authorities requirements. Submit Contractor's Material & Test Certificates for Above Ground Piping. Submit certificates of completion to Authority Having Jurisdiction and Owner.

1. After completion of all installation, tests, etc., and prior to the opening date, the Sprinkler Subcontractor shall instruct the building personnel in the operation of the sprinkler system. Special care shall be taken to make sure the building personnel:

a) Will immediately recognize whether the system control valves are in an 'Open' position or a 'Closed' position.

b) Will know how to drain the system.

c) Will know how to test the flow switches, tamper switches and alarm system.

d) Will know how to test the dry pipe valve.

e) Will know how to make complete weekly inspection.

f) Will know how to perform periodic maintenance of the Fire Sprinkler System.

B. Fire Alarm Equipment: Test per NFPA 25, NFPA 72 and local authorities requirements in the presence of the Owner. Submit certificates of completion to authority having jurisdiction and Owner.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP, or MEP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer’s requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC - Arkansas Building Code 2018

IMC - Arkansas Mechanical Code 2018

IPC - Arkansas Plumbing Code 2018

IFGC - Arkansas Fuel Gas Code 2018

ADA - American Disabilities Act

AMCA - Air Movement and Control Association, Inc.

ANSI - American National Standards Institute

AHRI - Airc Conditioning, Heating and Refrigeration Institute

ASHRAE - American Society of Heating Refrigerating and Air Conditioning Engineers

ASME - American Society of Mechanical Engineers

ASSE - American Society of Sanitary Engineering

ASTM - American Society of Testing Materials

AWS - American Welding Society

AWWA - American Water Works Association

CISPI - Cast Iron Soil Pipe Institute

ETL - Electrical Testing Laboratories

HI - Hydraulic Institute

MSS - Manufacturer's Standardization Society of the Valve and Fitting Industry

NBFU - National Board of Fire Underwriters

NEC - National Electrical Code

NFPA - National Fire Protection Association

NEMA - National Electrical Manufactures' Association

OSHA - Occupational Safety and Health Act

PDI - Plumbing and Drainage Institute

UL - Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. Furnish: When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a) Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b) Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.05 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.06 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.08 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper

submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time [or time specified in the Engineer's Agreement with the Client,] plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.

1.09 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

a) Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

b) Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

c) Proposed substitution has received necessary approvals of authorities having jurisdiction.

d) Same warranty will be furnished for proposed substitution as for specified Work.

e) If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f) Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.

B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Insulation shall be effective.

3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.18 TEMPORARY FACILITIES

A. Refer to Division 1 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, nonclogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

1.19 PROJECT CONDITIONS

A. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Provide clean sand, pea gravel or flowable fill material (per the geotechnical engineer's or structural engineer's recommendations).

B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially crushed aggregate. Corrosive fill materials shall not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and be free of debris, waste, frozen materials, vegetable and other deleterious matter.

PART 3 - EXECUTION

3.01 PERMITS

A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 ACCEPTANCE TESTING REQUIREMENTS

A. Perform acceptance test procedures in accordance with the specifications listed in the Reference Joint Appendices for the Building Energy Efficiency Standards of California. Reference the Non-Residential Certificate of Compliance (NRCC) forms on the drawings for the systems which shall be tested.

B. Submit Non-Residential Certificate of Acceptance (NRCA) forms for each system for which the CMATT is responsible.

3.03 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.

C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

E. Erect barricades around excavations. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.

1. Do not allow water to accumulate in excavations and trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Trenching: Excavate trenches for Plumbing installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.

5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

L. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35□F.

M. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below:

2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support after installation and testing of piping and

prior to backfilling and placement of roadway subbase. Coordinate with AHJ for colored concrete requirements.

5. Other areas, use excavated or borrowed materials.

O. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

P. Placement and Compaction: Place subgrade backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

S. Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Use of pneumatic backhoe as compaction method is not allowed as an acceptable process for compaction of excavations or trenches.

2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.

3. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent

water appearing on surface during, or subsequent to, compaction operations. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.

5. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

   a) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   b) Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   c) Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

T. Subsidence: Where subsidence occurs at Plumbing installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

U. Additional Excavation: Where additional excavation may be required due to unsuitable bearing materials encountered, notify the architect immediately for resolution.

3.04 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.05 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Start-up testing of systems.
4. Removal of temporary facilities from the site.
5. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

SPECIFICATION NUMBER	TITLE	CODE DESIGNATION
220500	COMMON WORK RESULTS FOR PLUMBING	B
220513	COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT	B
220515	BASIC PIPING MATERIALS AND METHODS	B
220516	EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING	A,B
220519	METERS AND GAUGES FOR PLUMBING PIPING	B,G,I
220523	GENERAL DUTY VALVES FOR PLUMBING PIPING	B,H,I
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING	B
220533	HEAT TRACING FOR PLUMBING PIPING	B,C,E,G,I
220548	SEISMIC CONTROLS FOR PLUMBING PIPING & EQUIPMENT	A,B,C
220550	VIBRATION ISOLATION FOR PLUMBING PIPING & EQUIPMENT	A,B,C
220553	IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT	B
220700	PLUMBING INSULATION	B
221100	WATER DISTRIBUTION PIPING & SPECIALTIES	A,B,F,H,I
221111	MECHANICALLY JOINED PLUMBING PIPING SYSTEMS	A,B,F,H,I
221112	PEX TUBING WATER DISTRIBUTION SYSTEM & SPECIALTIES	A,B,F,H,I
221113	POLYPROPYLENE WATER DISTRIBUTION PIPING & SPECIALTIES	A,B,F,H,I
221114	STAINLESS STEEL WATER DISTRIBUTION PIPING AND SPECIALTIES	A,B,F,H,I
221115	CPVC WATER DISTRIBUTION SYSTEMS & SPECIALTIES	A,B,F,H,I
221123	DOMESTIC WATER PUMPS	B,C,D,E,G,H,I
221300	SANITARY DRAINAGE PIPING & SPECIALTIES	A,B,F

221328	CONDENSATE PUMPS FOR HVAC EQUIPMENT	B,C,D
221329	SANITARY SEWERAGE PUMPS	B,C,D,E,G,H,I
221330	IN-LINE ELECTRIC SEWERAGE GRINDERS	B,D,E,I
221400	STORM DRAINAGE PIPING & SPECIALTIES	A,B,F
221410	SIPHONIC STORM DRAINAGE PIPING & SPECIALTIES	A,B,F
221450	INTERIOR SUBDRAIN SYSTEMS	A,B,F
221489	SUMP PUMPS	B,C,D,E,G,H,I
221500	GENERAL SERVICE COMPRESSED AIR SYSTEMS	A,B,C,D,E,F,G,H,I
221510	BEVERAGE SYSTEM BULK CO2 SYSTEMS	A,B,F,H
221520	FIREFIGHTER AIR REPLENISHMENT SYSTEM SPEC	A,B,C,D,E,F,G,H,I
223100	WATER SOFTENERS	B,C,D,E,G,H,I
223120	WATER FILTRATION SYSTEMS	B,C,D,E,G,H,I
223121	POINT OF ENTRY WATER FILTRATION SYSTEMS	B,C,D,E,G,H,I
223130	COPPER SILVER IONIZATION SYSTEM	B,C,D,E,G,H,I
223140	CHLORINE DIOXIDE SYSTEM	B,C,D,E,G,H,I
223200	DOMESTIC WATER FILTRATION EQUIPMENT	B,C,D,E,G,H,I
223300	ELECTRIC DOMESTIC WATER HEATERS	B,C,D,E,G,H,I
223700	HEAT PUMP DOMESTIC WATER HEATERS	B,C,D,E,G,H,I
223701	HYBRID HEAT PUMP DOMESTIC WATER HEATERS	B,C,D,E,G,H,I
223702	HEAT PUMP WATER HEATERS WATER SOURCE	B,C,D,E,G,H,I
223400	FUEL FIRED DOMESTIC WATER HEATERS	B,C,D,E,G,H,I
223500	DOMESTIC WATER HEAT EXCHANGERS	B,C,E,G,I
224000	PLUMBING FIXTURES	B,E,H,I
224600	SECURITY PLUMBING FIXTURES	B,E,H,I
226100	GAS & VACUUM SYSTEMS FOR MEDICAL FACILITIES	A,B,C,D,E,G,H,I

226200	**GAS & VACUUM SYSTEMS FOR LABORATORIES**	**A,B,C,D,E,G,H,I**
226600	**CHEMICAL WASTE SYSTEMS FOR LABORATORY AND MEDICAL FACILTIES**	**B,C,E,F,H**
226700	**PROCESS WATER PIPING AND EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES**	**A,B,C,D,E,G,H,I**
227000	**NATURAL GAS SYSTEMS**	**A,B,C,H**
227010	**MECHANICALLY JOINED NATURAL GAS PIPING SYSTEMS**	**B,F,H**
228000	**BEVERAGE CONDUIT SYSTEMS**	**A,B**

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.02 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.03 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Plumbing Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Plumbing Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections

C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

PART 3 - EXECUTION

3.01 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
EQUIPMENT MOTORS	DIV 22	DIV 22	DIV 26	---
FACTORY FURNISHED MOTOR STARTERS, CONTRACTORS AND DISCONNECTS	DIV 22	DIV 26	DIV 26	DIV 23
LOOSE MOTOR STARTERS, DISCONNECT SWITCHES, THERMAL OVERLOADS AND HEATERS	DIV 26	DIV 26	DIV 26	DIV 23
FACTORY ASSEMBLED CONTROL PANELS	DIV 22	DIV 26	DIV 26	DIV 23
CONTROL RELAYS AND TRANSFORMERS	DIV 22	DIV 22	DIV 26	DIV 23
THERMOSTATS (LINE VOLTAGE)	DIV 22	DIV 22	DIV 26	---
TIME SWITCHES	DIV 22	DIV 22	DIV 26	DIV 23
REMOTE PRESSURE SWITCHES (BOOSTER PUMPS)	DIV 22	DIV 22	---	DIV 23
TEMPERATURE CONTROL PANELS	DIV 22	DIV 22	DIV 26	DIV 23
VARIABLE SPEED DRIVES	DIV 22	DIV 22	DIV 26	DIV 23
MOTOR AND SOLENOID OPERATED VALVES	DIV 22	DIV 22	DIV 23	DIV 23
LABORATORY SAFETY DEVICES	DIV 22	DIV 26	DIV 26	DIV 23

DIV 22 = PLUMBING CONTRACTOR
DIV 26 = ELECTRICAL CONTRACTOR
DIV 23 = BUILDING AUTOMATION SYSTEM CONTRACTOR, REFER TO DIVISION 23 SECTION "DIRECT-DIGITAL CONTROL FOR HVAC".

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:

1. Non-shrink grout for equipment installations.
2. Sleeves for Plumbing penetrations.
3. Miscellaneous metals for support of Plumbing materials and equipment.
4. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
5. Joint sealers for sealing around Plumbing materials and equipment.
6. Plenum insulation for enclosure of combustible items located within fire-rated return air plenums.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 22 Section "Basic Ppiping Materials and Methods" for materials and methods for mechanical sleeve seals.
3. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties” for indirect drain piping and installation requirements.
4. Division 23 Section “Direct Digital Controls for HVAC” for integration with building automation system of leak detection system “Water Present” alarm.
5. Division 26 Section “Common Work Results for Electrical” required electrical devices.
6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 22 Section “General Plumbing Requirements”.

1. Product data for the following products:
   a) Through and membrane-penetration firestopping systems.
   b) Joint sealers.

2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.

3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

    a) Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

    a) Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.04 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound

pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

SPACE	RC LEVELS
SANCTUARY	25
CHOIR RISERS	25
STAGE	25
SOUND/LIGHTING CONTROL ROOMS	25
A/V SPACES	25
TV PRODUCTION STUDIO	25
DRAMA THEATRES	25
MUSIC TEACHING STUDIOS	25
TELECONFERENCE ROOMS	25
MEETING/BANQUET ROOMS	30
CONFERENCE ROOMS	30
COURTROOMS	30

PART 2 - PRODUCTS

2.01 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.02 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the

General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.03 DRIP PANS

A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2" lapped and soldered joints. Drip pan shall have a depth of 2" and a width of 6" in addition to the diameter of the associated pipe. Provide 3/4" galvanized pipe with male NPT outlet at low point of drip pan.

B. Drip pan supports shall be ¼" X 2" galvanized bar stock welded to the drip pan without holes.

2.04 LEAK DETECTION SYSTEM

A. Leak detection system with Rope style leak sensor and controller capable of connecting to a building automation system with audible and visual alarms for leak detection and cable failure in all drip pans unless otherwise noted on drawings. Provide with factory 24V DC power supply with power plug, sensing cables, and accessories.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) RLE Technologies #LD1000

2.05 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.06 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.07 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

a) "Dow Corning 790," Dow Corning Corp.

b) "Silglaze II SCS 2801," General Electric Co.

c) "Silpruf SCS 2000," General Electric Co.

d) "864," Pecora Corp.

e) "Rhodia 5C," Rhone-Poulenc, Inc.

f) "Spectrem 1," Tremco, Inc.

g) "Spectrem 2," Tremco, Inc.

h) "Dow Corning 795," Dow Corning Corp.

i) "Rhodia 7B," Rhone-Poulenc, Inc.

j) "Rhodia 7S," Rhone-Poulenc, Inc.

k) "Omniseal," Sonneborn Building Products Div.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

a) "Dow Corning 786," Dow Corning Corp.

b) "Sanitary 1700," General Electric Co.

c) "898 Silicone Sanitary Sealant," Pecora Corp.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:

1. Products: Subject to compliance with requirements, provide one of the following:

    a) "Chem-Calk 600," Bostik Construction Products Div.

    b) "AC-20," Pecora Corp.

    c) "Sonolac," Sonneborn Building Products Div.

    d) "Tremflex 834," Tremco, Inc.

2.08 ACOUSTICAL SEALANTS

A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

2.09 PLENUM INSULATION

A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated return air plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.

B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.

C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

D. Physical Properties: Plenum insulation shall be single ½" layer with a density of 6 to 8 pounds per cubic foot.

2.10 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:

1. 3M Corp., Fire Barrier Sealant
2. Hilti
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR
5. RectorSeal
6. Specified Technologies Inc.,
7. United States Gypsum Company SHEETROCK Firecode Compound
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.01 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.02 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.03 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.04 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.05 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

3.06 DRIP PANS

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.

C. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

D. Provide drip pan supports every 4'-0". Provide ¼" galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

E. Connect ¾" type "L" copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

F. Install leak detection rope in a zig-zag pattern covering entire length and width of the drip pan. Secure rope to pan per manufacturers recommendations.

G. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.

H. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section "Common Work Results for Electrical" Disconnects are specified in Division 26 Section "Enclosed Switches and Circuit Breakers"

I. Coordinate interlock of "Water Present" alarm and "Cable Fault" alarm with Building Automation System. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.

3.07 LEAK DETECTION SYSTEM FOR WATER HEATERS

A. Provide leak detection rope all around perimeter of water heater drip pan. Secure rope to pan per manufacturers recommendations.

B. Mount leak detection system controller where indicated on drawings.

C. Interlock control panel with building automation system for alarm signal for "Leak at Water Heaters" and "Cable Fault" alarm. Upon receiving leak alarm signal from control panel, building automation system shall energize motorized ball valve "MBV" to close. Motorized ball valve "MBV" is indicated and specified on the drawings. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.

3.08 ACOUSTICAL PENETRATIONS

A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the plumbing equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.

B. Domestic Water, Sewer, Drain and Vent Piping

1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

3.09 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated return air plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1" perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer's written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated return air plenums where the use of plenum insulation is not approved.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Single phase electric motors.

1.02 SUBMITTALS

A. General: Submit the following in accordance with conditions of contract and Division 1 specification Sections.

1. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.03 QUALITY ASSURANCE

A. All motors shall be UL listed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Century

B. General Electric

C. Westinghouse

D. Baldor

E. Gould

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors Less Than 250 Watts, for Intermittent Service: Provide equipment manufacturer's standard. Motor's need not conform to these specifications.

B. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

C. Type:

1. Open drip-proof except where noted otherwise.

2. Motors: Design for continuous operation in 40 degrees C environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

4. Motors with frame sizes 254T and larger: Energy Efficient Type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.03 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

PART 3 - EXECUTION

3.01 APPLICATION

A. Single phase motors for pumps and air compressors: Capacitor start type.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

3.03 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6 - 1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5 - 150	1.15	1.15	1.15	1.15

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

1.02 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

A. Refer to Division 1 and Division 22 Section “General Plumbing Requirements” for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Escutcheons
2. Dielectric Unions
3. Dielectric Waterway Fittings
4. Dielectric Flanges and Flange Kits
5. Mechanical Sleeve Seals
6. Wall Pipes
7. Strainers

C. Quality Control Submittals:

1. Submit welders' certificates specified in Quality Assurance below.

D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar

metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.04 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:
    a) AWI Manufacturing.
    b) Keeney Manufacturing Company
    c) Wal-Rich Corp.
    d) Jones Stephens Corp.
2. Dielectric Waterway Fittings:
    a) Elster Perfection Corporation.
    b) Grinnell Mechanical Products; Tyco Fire Products LP
    c) Precision Plumbing Products, Inc.
3. Dielectric Unions:

a) JOMAR International
b) Smith Cooper International
c) Watts Regulator Co.
d) Zurn Industries

4. Dielectric Flanges and Flange Kits:
   a) Advance Products & Systems
   b) Calpico, Inc.
   c) FMC Technologies
   d) Pipeline Seal & Insulator, Inc.
   e) Tampa Rubber and Gasket Co., inc.
   f) Watts Industries Inc.; Water Products Div.
   g) Zurn Industries, Inc.; Wilkins Div.
5. Strainers – 2" and smaller:
   a) Apollo
   b) Hammond
   c) Milwaukee
   d) NIBCO
6. Strainers – 2-1/2" and larger:
   a) Metraflex Co.
   b) Watts Regulator Co.
   c) Zurn Industries, Inc.; Wilkins Div.
7. Mechanical Sleeve Seals:
   a) Advance Products & Systems
   b) Calpico, Inc.
   c) GPT Industries/Link Seal
   d) Metraflex Co.
   e) Proco Products, Inc.
8. Wall Pipes
   a) Josam Mfg. Co.
   b) Smith (Jay R) Mfg. Co.
   c) Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
   d) Watts Industries, Inc.
   e) Zurn Industries, Inc.; Hydromechanics Div.

2.02 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.

B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

E. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.04 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions:

1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.

C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125

for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Dielectric Flanges and Flange Kits:

1. Full faced gasket with same outside diameter and bolt hole arrangement as the flange. Pressure rating of 200psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.
2. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.
3. Lead free cast bronze meeting ASTM B584, class 125 solder type or cast iron class 125 threaded type for low pressure service and bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

F. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens for 4” and smaller shall be Type 304 stainless steel mesh with 0.062” perforations and screens for 5” and larger shall be Type 304 stainless steel, with 0.125" perforations.

1. For low pressure applications, cast iron strainers shall have 125 psi working pressure rating and cast bronze strainers shall have 150 psi working pressure rating. For high pressure applications, cast iron strainers shall have 250 psi working pressure rating and cast bronze strainers shall have 300 psi working pressure rating.
2. Solder Ends, 2” and Smaller: Lead free cast bronze body meeting ASTM B584, screwed screen retainer with centered blowdown fitted with pipe plug.
3. Threaded Ends, 2-1/2" and Larger: Cast-iron body, with FDA fused epoxy coating, bolted screen retainer with off-center blowdown fitted with pipe plug.
4. Flanged Ends, 2-1/2" and Larger: Cast-iron body, with FDA fused epoxy coating, bolted screen retainer with off-center blowdown fitted with pipe plug.

G. Sleeves:

1. Sleeve: Refer to Division 22 Section “Common Work Results for Plumbing” for sleeve materials.

H. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.05 WALL PIPES

A. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.06 WALL SLEEVES

1. Steel sleeve of schedule 40 pipe meeting ASTM A53B with 2” wide metal plate meeting ASTM A36 welded all around. Hot dip galvanized inside and out.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s installation instructions.

3.02 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.03 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.

C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

I. Verify final equipment locations for roughing in.

3.04 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.05 PENETRATIONS

A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Provide escutcheons for exposed pipe penetrations of interior floors, walls, ceilings and under cabinets and millwork. Use deep pattern escutcheons where required.

C. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a) Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b) Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c) Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d) Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

D. Underground, Exterior-Wall Penetrations: Provide galvanized steel wall sleeve. Wall sleeve is not required for existing concrete walls with core drilled penetrations. Size wall sleeves to allow for 1-inch or larger, if required by the mechanical sleeve seal manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2. Verify sleeve and mechanical sleeve seal installations for damage and faulty work. Verify watertight integrity of sleeves and mechanical sleeve seals installed below grade to seal against hydrostatic water pressure. If sleeve and or sleeve seal are not watertight, provide new wall sleeve and mechanical sleeve seal.

E. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.

2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."

5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

F. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

G. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

2. Provide ½" thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2" above and below the concrete slab.

H. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe , using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

I. Exterior Wall Penetrations: Seal annular space between sleeve and pipe, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Cover exterior sealant with grout, minimum ½" thick and paint grout to match exterior color, with color selection by the architect. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

J. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

K. Acoustical Barrier Penetrations: Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. The internal diameter of the sleeve shall be a minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-

inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.

1. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.06 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install components with pressure rating equal to or greater than system operating pressure.

D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.

E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.

F. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2” and larger.

G. Install dielectric unions for piping 2” and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.

H. Install dielectric flanges for piping 2-1/2” and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.

I. Install dielectric unions for piping 2” and smaller to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

J. Install dielectric flanges for piping 2-1/2” and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

K. Install dielectric waterway fittings for piping 2” and smaller for copper or brass pipe connections to carbon steel equipment connections.

L. Install dielectric flanges for piping 2-1/2” and larger for copper or brass pipe connections to carbon steel equipment connections, steel, ductile iron or cast iron valves and fittings.

M. Dielectric Flange Installation:

1. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

2. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

3. Provide full face gasket with pressure rating equal to system served.

4. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.07 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2":

a) Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.

b) Weld pipe joints of exterior water service pipe in accordance with AWWA C206.

c) Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.08 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

C.

PLUMBING & PLUMBING PIPING SYSTEMS

INSPECTION REPORT FORM

PROJECT NAME:

PROJECT NO: _____ CONTRACTOR PROJECT NO. _____

GENERAL CONTRACTOR: _____

INSPECTION DATE: _____TEMPERATURE: _____

SYSTEM INSPECTED

BUILDING:

_____

LOCATION/DESCRIPTION:

_____

SERVICE:

_____

INSPECTION RESULTS

TIME OF INSPECTION: _____

APPROVAL TO INSULATE Y N APPROVAL TO COVER IN WALL: Y N

APPROVAL TO BACKFILL Y N

SIGNATURES

WITNESS: _____ REPRESENTING: _____

WITNESS: _____ REPRESENTING: _____

WITNESS: _____ REPRESENTING: _____

REMARKS

_____

_____

CONTRACTOR SUPERVISOR'S SIGNATURE:

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following types of meters and gauges:

1. Temperature gauges and fittings.
2. Pressure gauges and fittings.

1.02 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
2. Product certificates signed by manufacturers of meters and gauges certifying accuracy under specified operating conditions and products' compliance with specified requirements.
3. Maintenance data for each type of meter and gauge for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Glass Tube Industrial Thermometers:
   a) H. O. Trerice Co.
   b) Marshalltown Instruments, Inc.
   c) Miljoco Corporation
   d) Weiss Instruments, Inc.
   e) Weksler Instruments Corp.
   f) Winters Instruments
2. Bimetal Dial Thermometers:
   a) Ashcroft Dresser Industries Instrument Div.

b) Ernst Gage Co.

c) H. O. Trerice Co.

d) Marshalltown Instruments, Inc.

e) Miljoco Corporation

f) Tel-Tru Manufacturing Co., Inc.

g) Weiss Instruments, Inc.

h) Weksler Instruments Corp.

i) Winters Instruments

3. Insertion Dial Thermometers:

a) Ashcroft Dresser Industries Instrument Div.

b) H. O. Trerice Co.

c) Miljoco Corporation

d) Tel-Tru Manufacturing Co., Inc.

e) Weiss Instruments, Inc.

f) Weksler Instruments Corp.

g) Winters Instruments

4. Direct-Mount Filled-System Dial Thermometers:

a) Ashcroft Dresser Industries Instrument Div.

b) H. O. Trerice Co.

c) KOBOLD Instruments, Inc.

d) Marsh Instrument Co., Unit of General Signal.

e) Miljoco Corporation

f) Weiss Instruments, Inc.

g) Weksler Instruments Corp.

h) Winters Instruments

5. Thermometer Wells: Same as for thermometers.

6. Pressure Gauges:

a) Ametek, U.S. Gauge Div.

b) Ashcroft Dresser Industries Instrument Div.

c) Ernst Gage Co.

d) H. O. Trerice Co.

e) Marsh Instrument Co., Unit of General Signal.

f) Marshalltown Instruments, Inc.

g) Miljoco Corporation

h) Weiss Instruments, Inc.

i) Weksler Instruments Corp.

j) WIKA Instruments Corp.

k) Winters Instruments

7. Pressure Gauge Accessories: Same manufacturers as for pressure gauges.

2.02 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:

1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).

2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.03 GLASS TUBE INDUSTRIAL THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Non-red color reading, non-toxic organic spirit-filled glass tube, magnifying lens.

D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.04 BIMETAL DIAL THERMOMETERS

A. Type: Direct mounted, bimetal, universal angle.

B. Case: Stainless steel, glass lens, 5-inch diameter.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Element: Bimetal coil.

E. Scale: Satin faced, nonreflective aluminum, permanently etched marking.

F. Stem: Stainless steel for separable socket, length to suit installation.

2.05 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal, stainless steel case and stem, 1-inch-diameter dial, dust- and leakproof, 1/8-inch-diameter tapered-end stem with nominal length of 5 inches.

2.06 DIRECT-MOUNT FILLED-SYSTEM DIAL THERMOMETERS

A. Type: Vapor actuated, universal angle.

B. Case: Drawn steel or cast aluminum, glass lens, 4-1/2-inch diameter.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Thermal Bulb: Copper with phosphor bronze bourdon pressure tube.

E. Movement: Brass, precision geared.

F. Scale: Progressive, satin faced, nonreflective aluminum, permanently etched markings.

G. Stem: Copper-plated steel, aluminum, or brass, for separable socket, length to suit installation.

2.07 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.08 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.

B. Case: Cast aluminum or stainless steel case, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

G. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.09 PRESSURE GAUGE ACCESSORIES

A. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

PART 3 - EXECUTION

3.01 THERMOMETERS INSTALLATION

A. Install in the following locations and elsewhere as indicated:

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.02 INSTALLATION OF PRESSURE GAUGES

A. Install in the following locations, and elsewhere as indicated:

1. Provide liquid-filled gauge at suction and discharge of each pump.
2. At discharge of each pressure-reducing valve.
3. At building water service entrance.

B. Pressure Gauge Needle Valves: Install in piping tee with snubber.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes general duty valves common to most plumbing water distribution piping systems.

1. Special purpose valves are specified in individual piping system specifications.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined plumbing piping systems to connect plumbing piping where used shall be provided in compliance with specification Section 221111 “Mechanically Joined Plumbing Piping Systems”.

1.02 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

B. CWP: Cold Working Pressure.

C. EPDM: Ethylene Propylene Diene Mono Copolymer Rubber.

D. NRS: Non-Rising Stem.

E. OS&Y: Outside Screw and Yoke.

F. PTFE: Polytetrafluorethylene.

G. RS: Rising Stem.

H. TFE: Tetrafluoroethylene.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim

material and arrangement, dimensions and required clearances, and installation instructions.

B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.

B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:

1. MSS SP 80 “Bronze Gate, Globe, Angle and Check Valves”
2. MSS SP 110 “Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends”
3. MSS SP 125 “Check Valves: Gray Iron and Ductile Iron, In-Line, Spring Loaded, Center-Guided”

D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

2.02 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or rising outside screw and yoke stems.

1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever handles, on quarter-turn valves 6-inch and smaller.
3. Chain-wheel operators, for valves 2-1/2-inch and larger, installed 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
4. Gear drive operators, on quarter-turn valves 8-inch and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
3. Solder-Joint: Comply with ANSI B16.18.
   a) Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.03 GATE VALVES

A. Gate Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body, solid wedge and bonnet of ASTM B 584 lead free cast bronze; brass packing gland and stem of ASTM B283 naval brass; with solder ends, non-asbestos composition packing, and malleable iron handwheel.

2.04 BALL VALVES

A. Ball Valves, 2 Inch and Smaller: Meeting MSS SP 110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, , with replaceable TFE seats and seals, solder ends and vinyl-covered steel handle.

2.05 CHECK VALVES

A. Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, disc and disc holder of ASTM B 283 alloy C46400 naval brass; solder ends. Provide valves capable of being reground while the valve remains in the line.

B. Wafer Check Valves: Meeting MSS SP 125, Class 125, 200-psi CWP, lead free cast-iron body, with FDA epoxy coating, replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

PART 3 - EXECUTION

3.01 INSTALLATIONS

A. Install valves in accordance with manufacturer's installation instructions.

B. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Wafer Check Valves: Horizontal or vertical position, between flanges.

3.02 VALVE ENDS SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-Inch and Smaller: Solder ends.
2. Copper Tube Sizes 2-1/2 Inch and Larger: Fflanged ends.

3.03 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

A. Domestic Hot and Cold Water Service

VALVE TYPE	2" AND SMALLER	2-1/2" AND LARGER
Ball	150	200
Butterfly	N/A	200
Gate	125	125
Globe	125	125
Check	125	125

3.04 VALVE SCHEDULE

A. Gate Valves - 2 inch and smaller:

MANUFACTURER	SOLDER NRS

Apollo	102S-LF
Hammond	UP-668
Milwaukee	UP-668
NIBCO	S-113-LF

B. Gate Valves - 2-1/2 inch and larger - Class 125:

MANUFACTURER	OS&Y RS	NRS
Apollo	611F-LF1	610-LFA

C. Ball Valves (full port) – 2 inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

D. Swing Check Valves – 2 inch and smaller - Class 125:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo	161S-LF	161T-LF
Milwaukee	UP1509	UP509
NIBCO	S-413-Y-LF	T-413-Y-LF

E. Swing Check Valves - 2-1/2 inch and larger – Class 125:

MANUFACTURER	FLANGED ENDS
Apollo	910F-LFA

F. Wafer Check Valves – Class 125:

MANUFACTURER	MODEL
Apollo	910WB-LF

G. Lift Check Valves – 2 inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Hammond	UP947	UP943
Milwaukee	UP1548T	UP548T
NIBCO	S-480-Y-FL	T-480-Y-LF

3.05 APPLICATION SCHEDULE

A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Gate Valves, 2" and smaller: Class 125, with cast bronze body.
2. Ball Valves, 2" and Smaller: Class 150, 600-psi CWP, with stem extension if installed in insulated pipe.
3. Swing Check, 2" and smaller: Class 125, cast bronze, with rubber seat.
4. Check Valves, 2-1/2" and larger: Class 125, swing or wafer type as indicated.

3.06 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.07 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal-piping hangers and supports.

C. Shields

D. Vertical piping clamps

E. Pipe alignment guides.

F. Pipe anchors.

G. Pre-engineered roof supports

H. Anchors and fasteners.

I. Miscellaneous materials.

J. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
2. Division 22 “Water Distribution Piping and Specialties”, for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
3. Division 22 “Sanitary Drainage & Vent Piping and Specialties”, for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.
4. Division 22 “Storm Drainage & Piping and Specialties”, for pipe hanger types and spacing for horizontal and vertical storm drainage piping of sizes and materials indicated.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.03 SUBMITTALS

A. Product Data : Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, and shields at pipe hangers for each type of insulation and hanger.

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.06 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.

2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.

3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

   a) Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

   b) Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.

   c) Outdoor Locations: Galvanized steel or type 304 stainless steel.

   d) Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.

   e) Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

   f) Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

   g) Stainless Steel: Type 304 or 316 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:

   a) Cooper B-Line.

   b) Ferguson Enterprises/FNW.

   c) PHD Manufacturing.

   d) Thomas & Betts Corporation.

   e) Unistrut, a brand of Atkore International Inc.

   f) Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-69, Type 59, MSS SP-89, and MFMA-4. Welds shall comply with AWS D1.1.

4. Channel Material:

   a) Indoor Dry Locations: Galvanized steel or zinc-plated steel.

   b) Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.

   c) Outdoor Locations: Galvanized steel or type 304 stainless steel.

   d) All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Material:

a) Indoor Dry Locations: Zinc-plated steel.

b) Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.

2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.

4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.02 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. MANUFACTURERS

1. ASC Engineered Solutions.

2. Cooper B-Line, Inc.

3. Elite Components

4. ERICO/Michigan Hanger Co./Caddy

5. Ferguson/FNW.

6. Halfen-DEHA.

7. Hilti.

8. National Pipe Hanger Corporation.

9. PHD Manufacturing.

10. Power-Strut.

11. Unistrut.

B. Single Hangers:

1. Split Ring: Carbon steel, adjustable swivel, split ring type.

2. Split Ring 2 inch and smaller: Copper alloy, split ring type.

3. Clevis Hanger: Carbon steel, adjustable, clevis type.

4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.

2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:

a) ASC Engineered Solutions.

b) Holdrite.

c) Klo-Shure.

2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

F. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

G. Pre-Insulated Supports:

1. Manufacturers:

a) Aeroflex USA, Inc.

b) ASC Engineered Solutions

c) Armacell.

d) Buckaroos, Inc.

e) Cooper B-Line, Inc.

f) Pipe Shields, Inc.

2. General Construction and Requirements:

a) Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.

b) Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

c) Waterproof calcium silicate insulation shall conform to ASTM C795.

d) Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.

e) Insulation inserts shall be surrounded by a 360 degree jacket or shield.

3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.03 SHIELDS

A. Insulation Protection Shield:

1. Sheet metal construction, meeting SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension.

2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.

4. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft) 5	6	7	8	9	10
	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
< 1	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
<2	0.5	8	8	11	11	12	14

1	5	6	8	9	11	11
1.5	5	6	8	8	9	9
2	5	5	6	6	8	8
3	5	5	6	6	6	8

B. 360 Degree Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

C. Plastic Shields:

1. Manufacturers:
   a) Armacell.
   b) Eaton.
   c) Hydra-Zorb.
   d) PHD Manufacturing.
   e) Zsi Foster.
2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.04 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Halfen-DEHA.
4. Hilti.
5. ERICO/Michigan Hanger Co.
6. National Pipe Hanger Corporation.
7. PHD Manufacturing.
8. Power-Strut.
9. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.

2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:

a) Hydra-Zorb; Titan Riser Clamp.

b) National Pipe Hanger.

c) Pipe Hangers, Inc.

D. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.05 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.

2. Pipe Diameter 10 inches and Larger: Roller type.

3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.06 PIPE ANCHORS

A. Pre-Insulated Anchors: Galvanized steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.

B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.07 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Manufacturers:

1. Airtec.

2. ASC Engineered Solutions.

3. Cooper B-Line, Inc.

4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy.
6. Ferguson/FNW.
7. Miro.
8. PHP Systems/Design.
9. PHD Manufacturing.
10. Roof Top Blox.
11. Unistrut, a brand of Atkore International Inc.
12. Zsi Foster.

B. General: Pre-engineered devices with embedded pipe support fixtures as specified.

C. Pedestals: Steel pedestals with thermoplastic or rubber base with the following dimensions:
1. Up to 12 inch strut length support: 18 inch x 18 inch.
2. Up to 16 inch strut length support: 24 inch x 18 inch.
3. Up to 24 inch strut length support: 30 inch x 18 inch.
4. Thickness: Minimum 3/16 inch thick.

D. Block Bases: Closed-cell polyethylene blocks with the following dimensions.
1. Length: Nominal 10 inch, 12 inch, 16 inch, or 24 inch
2. Width: Nominal 4 inches.

E. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

F. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

2.08 ANCHORS AND FASTENERS

A. Manufacturers:
1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:
    a) Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
    b) Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.
2. Channel Material: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.
5. Manufacturers:
    a) Same as manufacturer of metal channel (strut) framing system.
    b) DeWalt “Bang-It” concrete inserts.

D. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.

2.09 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION, GENERAL

A. Install hangers and supports in accordance with manufacturer's installation instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.03 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 22 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Division 22 Section “Plumbing Insulation” for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
2. Where strut systems are attached to walls, install anchor bolts per manufacturer’s recommendations.
    a) Uninsulated Copper Pipe: Install with plastic galvanic isolators
    b) Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section “Plumbing Insulation”.

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section “Plumbing Insulation”.

    a) Contractor’s Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.

2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section “Plumbing Insulation”. Do not use polymer-based shields for hot piping.

    a) Exception for horizontal cold piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.

3. Contractor’s Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

4. Contractor’s Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".

P. Vertical Piping Risers:

1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for piping riser supports.

Q. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

R. Pre-Engineered Roof Pipe Supports: Set supports on an 18" X 18" x 3/16" thick roof walkway material compatible with the roof material.

3.04 INSTALLATION OF PIPE ALIGNMENT GUIDES

A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise. Install pipe insulation at guide to not interfere with movement of pipe within the guide.

B. Install guide to accommodate 1/2 the thermal movement at the adjacent expansion joint.

C. Anchor to building substrate.

3.05 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.06 EQUIPMENT SUPPORTS

A. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

B. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Remove temporary supports.

E. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

F. Grouting: Place grout under supports for piping and equipment.

3.07 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.08 FIELD QUALITY CONTROL

A. Examine support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.09 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

C. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:
   a) Band hanger.
   b) Swivel split ring.
   c) Clevis hanger.
2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.
3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.
4. All drainage pipe sizes: Clevis hanger.

D. Trapezes and Strut-mounted Supports:

1. All pipe sizes less than 6 inches: Two-piece clamp.
2. Pipe sizes 6 inches and greater: Roll support.

E. Wall Supports:

1. Pipe sizes 3 inches and less:
   a) Two-hole strap mounted to wall.
   b) Welded steel bracket with reinforced angle or strut.
2. Pipe sizes 4 inch and greater:
   a) U-bolt
   b) Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipe sizes 4 inch and less: Pipe saddle.
2. Pipe sizes 6 inch and greater: Roll support.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

B. Types of identification devices specified in this Section include the following:

1. Plastic Pipe Markers
2. Plastic Tape
3. Underground-Type Plastic Line Marker
4. Valve Tags
5. Engraved Plastic-Laminate Signs
6. Plastic Equipment Markers
7. Plasticized Tags

1.02 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

C. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section “General Plumbing Requirements.”

1.04 SPARE PARTS

A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:

1. Advanced Graphic Engraving, LLC.
2. Brady Co.
3. Brimar Industries, Inc.
4. Craftmark.
5. Kolbi Pipe Marker Co.
6. Seton

2.02 PLUMBING IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.03 PLASTIC PIPE MARKERS

A. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Laminated or bonded application of pipe marker to pipe (or insulation).
4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

B. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

C. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

2.04 PLASTIC TAPE

A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.05 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.06 VALVE TAGS

A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

1. Provide 1-1/2" diameter tags, except as otherwise indicated.
2. Fill tag engraving with black enamel.

B. Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

1. Provide 1-1/2" sq. black tags with white lettering, except as otherwise indicated.

C. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16" high letters and sequenced valve numbers approximately 3/8" high, and with 5/32" hole for fastener.

1. Provide 1-1/8" sq. white tags with black lettering.

D. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.07 CEILING TACKS

A. Description: Steel with 3/4” diameter color coded head.

B. Color:

1. Comply with ANSI A13.1, except where another color selection is indicated.

2.08 ACCESS PANEL MARKERS

A. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.09 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for plumbing fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.10 PLASTIC EQUIPMENT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of the above criteria.
6. For hazardous equipment, provide colors and designs recommended by ANSI A13.1.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and plan number.
2. Equipment service.
3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.11 PLASTICIZED TAGS

A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.12 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Application: Provide piping system identification for the following systems:

1. Domestic cold water piping.
2. Domestic hot water piping.
3. Domestic hot water recirculating piping.
4. Non potable water piping
5. Sanitary and waste piping.
6. Storm water piping.
7. Vent piping.
8. Insulated and non-insulated storm water piping.
9. Natural gas piping.

C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

3.03 UNDERGROUND PIPING IDENTIFICATION

A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.04 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.

B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.05 CEILING TACK INSTALLATION

A. Install ceiling tacks to locate valves above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.06 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Meters, gauges, thermometers and similar units.
3. Pumps
4. Water heaters, tanks and pressure vessels.

B. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping Insulation.

1.02 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees Fahrenheit.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees Fahrenheit.

C. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees Fahrenheit.

D. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees Fahrenheit.

E. Exposed: Insulation that is visible from the occupied space.

F. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.

G. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.

H. NAIMA: North American Insulation Manufacturers Association

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation.

B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.

D. Samples: Submit two samples of any representative size for each insulation type required. Affix label to sample completely describing product.

E. Manufacturer’s Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Flame/Smoke Ratings: Provide composite plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1. Exception: Exterior plumbing insulation may have flame spread index of 75 and smoke developed index of 150.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.06 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 PIPING INSULATION MATERIALS

A. Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a) CertainTeed Corp.

b) Knauf Insulation

c) Johns Manville

d) Owens Corning

2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.

a) K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees Fahrenheit.

b) Minimum Service Temperature: 0 degrees Fahrenheit

c) Maximum Service Temperature: 850 degrees Fahrenheit for Type I, 1200 degrees Fahrenheit for Type II.

d) Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.

3. Factory Applied Jacket: ASTM C1136, Type I.

a) All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.

b) Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.

c) Color: White.

B. Calcium Silicate:

1. Manufacturers:

a) CertainTeed Corp.

b) Johns Manville.

c) Knauf Insulation.

d) Owens Corning.

2. Insulation: ASTM C533, Type I, rigid molded, asbestos free, pre-formed for the application.

a) K-value: ASTM C335 or C518, maximum 0.45 at 200 degrees Fahrenheit.

b) Minimum Service Temperature: 80 degrees Fahrenheit

c) Maximum Service Temperature: 1200 degrees Fahrenheit.

d) Density: Maximum 15 pounds per cubic feet.

C. Flexible Elastomeric:

1. Manufacturers:

a) Aeroflex USA, Inc.

b) Armacell LLC.

c) K-Flex USA.

2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.

a) K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees Fahrenheit.

b) Minimum Service Temperature: Minus 297 degrees Fahrenheit

c) Maximum Service Temperature: 220 degrees Fahrenheit for Grade I, 300 degrees Fahrenheit for Grade II.

3. Factory Applied Jacket:

a) Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Jacket requirements in Part 3 of this specification for application of this jacket.

D. Polyolefin:

1. Manufacturers:

a) K-Flex

b) Sekisui Voltek

2. Insulation: ASTM C1427, physically crosslinked closed cell polyolefin foam, pre-formed for the application.

a) K-value: ASTM C518, maximum 0.22 at 75 degrees Fahrenheit.

b) Minimum Service Temperature: Minus 112 degrees Fahrenheit.

c) Maximum Service Temperature: 212 degrees Fahrenheit.

d) Density: Maximum 1.5 pounds per cubic feet.

3. Factory Applied Jacket: ASTM C1136, Type I.

a) Reinforced aluminum foil with acrylic adhesive backing, water vapor permeance of 0.002 perm-in in accordance with ASTM E96.

b) Heavy duty multilayer composite with UV resistance and salt resistant coating.

E. Field-Applied Jacket:

1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.

a) Outdoor Applications: Provide minimum 30 mils thickness and UV protection.

b) Manufacturers:

1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers

2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.

3) Or approved equal.

2. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in) Finish	Minimum Aluminum Jacket Non-Rigid Insulation	Jacket Thickness, (in) Rigid Insulation

Stucco ≤ 8	.016	.016
Stucco ≤ 12	.020	.016
Stucco ≤ 24	.024	.016

a) Banding:

1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.

2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

a) Water Vapor Transmission: 0.0 perms per ASTM E96.

b) Puncture Resistance: Minimum 65 pounds per ASTM D1000.

F. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.

G. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.

2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F1249.

4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Installation Application	Insulation Permability, Less than 4.0 perm-in. (Note 2) Vapor Retarder perms	Insulation Permability, 4.0 or greater perm-in. (Note 2)
Pipe and vessels (33 F to ambient)	.05	.05
Pipe and vessels (-40 F to 32 F)	.02	.02

5. Notes:

6. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.

7. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

H. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

I. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

J. High Density Insulation Billets:

1. Calcium Silicate: ASTM C533 and C795.

K. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW.

a) Water Vapor Transmission: 0.0 perms per ASTM E96.

b) Puncture Resistance: Minimum 65 pounds per ASTM D1000.

L. Pipe Insulation Accessories: Provide staples, Bands, Wires, and Cement and other appurtenances as recommended by insulation manufacturer for applications indicated.

M. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

N. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

O. High Density Insulation Billets:

1. Cellular Glass: ASTM C552.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Repair existing plumbing insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.

C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.03 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's installation instructions.

B. Install in accordance with NAIMA National Insulation Standards.

3.04 PLUMBING PIPING SYSTEM INSULATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Cold Piping Insulation:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide with factory applied vapor barrier jacket.
3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for Plumbing Piping" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.

F. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture infiltration.

G. Hot Piping Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.

2. Provide jackets without vapor barrier. Jackets with factory applied vapor barrier are allowed.

3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for Plumbing Piping” for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Secure all-service jacket with self-sealing longitudinal laps.

6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

3.05 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.

C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

E. Clean and dry pipe surfaces prior to insulating.

F. Cold Pipe Insulation:

1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.

2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports.

3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section “Hangers & Supports for Plumbing Piping” for insulation shields.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

G. Hot Pipe Insulation:

1. Provide pipe hangers for hot piping sized for the outside diameter of piping.

2. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. Seal exposed insulation at hanger with joint sealant.

H. Pipe insulation:

1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.

2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports.

3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section “Hangers & Supports for Plumbing Piping” for insulation shields.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints.

6. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints.

7. For cold pipes, apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

I. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves (except balancing and flow control valves), strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Butt tightly against adjoining pieces and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control valves), flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

J. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

K. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

L. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

3.06 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.07 PIPING SYSTEM INSULATION SCHEDULE

A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.

B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.

C. Omit insulation on the following:

1. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.

2. Chrome-plated exposed piping

3. Water Hammer Arrestors

4. Balancing and flow valves

5. Drain lines from water coolers
6. Drainage piping located in crawl spaces or tunnels
7. Exterior condensate drain piping
8. Buried piping
9. Pre-insulated equipment.

D. Cold Piping (minimum operating temperature less than 60 degrees Fahrenheit.)

1. Service
   a) Potable cold water piping.
   b) Non-potable cold water piping
   c) Potable chilled water piping.
   d) Plumbing vents within 6 lineal feet of roof outlet.
   e) Horizontal interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
   f) Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
   g) Horizontal and vertical interior above-ground overflow storm drainage piping and vertical run from roof drain to horizontal run. Where vertical overflow storm drainage piping from the outlet exceeds 15 feet, only insulate within 15 feet of the outlet.
   h) Lawn irrigation piping.
   i) Condensate piping inside the building.
2. Insulate each piping system specified above with one of the following types of insulation.
   a) Mineral fiber.

E. Hot Temperature Piping (105 degrees to 180 degrees Fahrenheit:

1. Service:
   a) Hot water supply and return piping.
2. Insulate each piping system specified above with one of the following types of insulation.
   a) Mineral fiber.

3.08 PIPE INSULATION THICKNESS SCHEDULE

A. P-traps:

1. Insulate P-traps receiving chilled water waste and P-traps of water coolers as described below:

a) Flexible Elastomeric: 1" thick for pipe sizes up to and including 2", 1-1/2” thick for pipe sizes 2” to 6” (largest size permitted).

2. Insulate P-traps receiving hot water waste above 140F as described below:

a) Fiberglass: 1" thickness.

b) Flexible Elastomeric (high temp formula up to 300F): 1” thickness.

B. Piping Inside Masonry Wall Units:

1. Insulate cold, hot, and hot water recirculation piping installed inside of masonry walls where the piping needs to be insulated as the wall is constructed as described below:

a) Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1” thick for pipe sizes 2-1/2” to 6” (largest size permitted).

3.09 PIPING JACKET SCHEDULE

A. Exposed piping within mechanical rooms (below 10 feet:

1. Semi-rigid PVC.

2. Rigid aluminum shell.

B. Exposed piping within mechanical rooms (above 10 feet:

1. Semi-rigid PVC.

2. Rigid aluminum shell.

C. Exposed piping:

1. All-service jacket.

2. Poly ASJ jacket, painted with color per architect and paint per division 7.

3. Semi-rigid PVC.

D. Piping within return air plenums:

1. All-service jacket.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 “Mechanically Joined Plumbing Piping Systems”.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 2 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building.
3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
4. Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges, and mechanical sleeve seals.
7. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
8. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials, and methods for hanging and supporting water distribution piping.
9. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.

10. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties,” for material and methods for trap primer outlet piping.

D. Products installed but not furnished under this Section include service water meters that will be furnished by the utility company to the site and ready for installation. Following is the name and address of the utility company:

_____

_____

_____

1.02 DEFINITIONS

A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.

B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.

C. Pipe sizes used in this Specification are nominal pipe size (NPS).

D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

E. Service Water Meter: Refers to the water meter at the water service tap for monitoring and billing the building’s water usage.

F. Deduct Meter: Refers to a secondary water meter that measures the amount of water used for irrigation or feeding cooling towers, which doesn't enter the sewer system. The meter allows the amount of water used for irrigation or feeding cooling towers to be deducted from the total water used for calculating the sewer bill.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

1. Product data for each piping specialty and valve specified.
2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Test reports specified in Part 3 of this Section.

6. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following specialties need not comply:

   a) Hose bibbs

   b) Wall, yard, and roof hydrants

   c) Backflow preventers isolating irrigation or mechanical make-up systems

   d) Trap primers

1.04 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Pipe, fittings, and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

1.05 SPARE PARTS

A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automatic Flow Control Valves:

   a) Calefi

   b) Flow Design, Inc., Autoflow Div.

c) Victaulic Company

2. Hose Bibbs with Vacuum Breaker:
   a) Chicago Faucet Co.
   b) Eljer, A Household International Company
   c) T & S Brass & Bronze Works, Inc.
3. Hose Bibbs:
   a) Lee Brass Co.
   b) Mansfield Plumbing Products
   c) Mifab Manufacturing, Inc.
   d) Nibco, Inc.
   e) Prier, Inc.
   f) Watts Regulator Co.
   g) Woodford Mfg. Co.
4. Wall/Yard Hydrants:
   a) Josam Co.
   b) Mifab Manufacturing, Inc.
   c) Smith (Jay R.) Mfg. Co.
   d) Prier, Inc.
   e) Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
   f) Watts Drainage
   g) Woodford Mfg. Co.
   h) Zurn Industries Inc., Hydromechanics Div.
5. Backflow Preventers:
   a) Cla-Val Co.
   b) Conbraco Industries, Inc.
   c) Febco
   d) Hersey Products, Inc.
   e) Mifab Manufacturing, Inc./Beeco
   f) Watts Regulator Co.
   g) Zurn Industries Inc. Wilkins Regulator Div.
6. Relief Valves:
   a) Cash (A. W.) Valve Mfg. Corp.
   b) Conbraco Industries, Inc.
   c) Watts Regulator Co.

d) Zurn Industries, Inc. Wilkins Regulator Div.

7. Piston Type Water Hammer Arresters:
   a) Amtrol, Inc.
   b) Josam Co.
   c) Precision Plumbing Products, Inc.
   d) PROFLO
   e) Sioux Chief Manufacturing Co.
   f) Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
   g) Watts Regulator Co.
   h) Zurn Industries, Inc. Wilkins Regulator Div.
8. Point of Use Thermostatic Mixing Valves
   a) Acorn Engineering Co.
   b) Cash Acme
   c) Leonard Valve Co.
   d) Powers Process Controls
9. Trap Primers and Distribution Units
   a) Mifab Manufacturing, Inc.
   b) Precision Plumbing Products, Inc.
   c) PROFLO
   d) Sioux Chief
10. Plumbing Pipe Support Brackets
   a) Holdrite
   b) PROFLO
   c) Sioux Chief
11. Tube Suspension Clamps
   a) PROFLO
   b) Sioux Chief or approved Equivalent

2.02 PIPE AND TUBE MATERIALS, GENERAL

A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or “Below Ground Water Distribution Pipe and Fittings”, for identification of systems where the materials listed below are used.

B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.

C. Copper Tube: ASTM B88, Type K Water Tube, annealed temper.

D. Ductile-Iron Pipe: AWWA C151 or AWWA C115 ductile-iron pipe, with AWWA C104 cement-mortar lining.

E. Brass Pipe: Chrome Plated Schedule 40 ASTM B43 iron pipe size (IPS.)

2.03 FITTINGS

A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.

B. Ductile or Gray-Iron Flanged Fittings: AWWA C110 Class 125 with AWWA C116 epoxy coating inside and outside.

C. Ductile-Iron Gasketed Fittings: AWWA C153, 150 psi rating, with AWWA C104 cement mortar lining and AWWA C111 rubber gaskets.

D. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.

2.04 JOINING MATERIALS

A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.

B. Brazing Filler Metals: AWS A5.8, Bag-7 Silver.

C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.05 GENERAL-DUTY VALVES

A. General-duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 22 Section "General Duty Valves for Plumbing Piping." Special duty valves are specified below by their generic name; refer to Part 3, Article "Valve Applications" for specific uses and applications for each valve specified.

2.06 SPECIAL DUTY VALVES

A. Automatic Flow Control Valves: 400 PSI WOG, flow regulator, with series 300 stainless steel body, series 300 stainless steel automatic pre-set flow balancing cartridge, union connection body, and threaded-end connections.

2.07 PIPING SPECIALTIES

A. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B1.20.7.

B. Hose Bibbs: Bronze body with chrome- or nickel-plated finish, with renewable composition disc, integral vacuum breaker, wheel handle, 1/2- or 3/4-inch solder inlet, hose outlet.

C. Backflow Preventers: Comply with requirements of ASSE Standard 1013 and as specified on the drawings.

D. Relief Valves: Sizes for relief valves shall be in accordance with ASME Boiler and Pressure Vessel Codes for indicated capacity of the appliance for which installed.

E. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Temperature relief valves shall be factory set at 210 deg F, and pressure relief at 150 psi.

F. Piston Type Water Hammer Arresters: Piston type, with casing of type "L" copper tube and spun copper ends, nylon piston with two EPDM "O"rings pressure lubricated with FDA approved silicone, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

G. Point of Use Thermostatic Mixing Valves:

1. Lead free bronze or brass body meeting ASTM B584 with non-corrosive parts, tamper resistant temperature adjustment, checks, stops, other components as scheduled and meeting ASSE 1070. Valve shall be designed to fail to the cold side of the system. Maximum pressure drop shall not be exceeded for the scheduled flow rate.

H. Trap Primers: Brass construction, line pressure operation, capacity to prime number of traps as indicated with distribution units complying with requirements of ASSE Standard 1018.

I. Pipe Support Brackets:

1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of 1/2" on 2" centers and holes of 3/4" or 1" on 4" centers.

2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.

3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.

J. Tube Suspension Clamps

1. Combination plastic supports and insulators for installing copper tube in stud walls with integral bracket for securing to stud with screws.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

3.02 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Copper Tube: Provide 6" thick sand pipe bed underneath and around sides of pipe, up to middle half of the pipe. Support pipe in trench with sand bags level and true at fittings to prevent sand, gravel or debris from interfering with the brazing process. After pressure testing is complete, install bedding at fittings and install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

B. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe up to middle half of the pipe, including fittings. After pressure testing is complete, provide first layer of pea gravel backfill 6" above pipe, tamp backfill with mechanical tamper and install bedding at fittings and install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.03 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.

B. Install chrome plated brass pipe and fittings for exposed water piping within the building where indicated on the drawings.

C. Install ductile or gray-iron epoxy coated fittings for 3" and larger at water service entrance riser and only upstream of the backflow preventer.

3.04 BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install Type K, soft annealed copper tube and brazed joints for pipe sizes 2 inches and smaller, with minimum number of joints, inside and outside building.

B. Install cement-lined ductile-iron pipe with rubber gasketed joints, inside and outside under the building, for pipe 3 inches and larger.

3.05 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe

sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.

I. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section “Common Work Results for Plumbing” for special sealers and materials.

J. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section “Basic Piping Materials and Methods” for additional information.

K. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods” for special sealers and materials.

L. Install piping level with no pitch.

3.06 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping”. Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.

3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".

4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.

   a) Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Plumbing Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.

5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.

6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.

7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and 360□ insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.

8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.

9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.

   a) Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.

   b) Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.

10. Secure copper tubes for flush valve wall mounted water closets to the chair carrier with carrier brackets.

11. Provide roll hangers for individual horizontal runs 100 feet or longer.

C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size - In.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - Inv.
Up to 1-1/4	6	3/8
1-1/2 to 2	10	3/8
2-1/2 to 4	10	3/8
5	10	1/2
6	10	1/2
8	10	1/2
10 to 12	10	5/8
14	N/A	3/4
16	N/A	7/8

1. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.

D. Support water piping within 12” of each elbow or tee and for water piping 2-1/2” and larger at each valve or strainer.

E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

3.07 PIPE AND TUBE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.

2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.

3. Heat joints to proper and uniform temperature.

C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

    a) Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

E. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".

F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.08 SERVICE ENTRANCE

A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building. Water service piping is specified in a separate section of Division 2.

B. Underground exterior water distribution piping to be a depth as required by local conditions, in accordance with authority having jurisdiction's requirements and at depth no less than 18" below grade.

C. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

D. Install sleeve and caulk at penetrations through building floor for watertight installation.

E. Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.

F. Ductile-Iron Pipe: Install in accordance with AWWA C-600. Pipe below ground inside building and to a point 5 feet outside of building shall have restrained joints.

3.09 VALVE APPLICATIONS

A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shut-off duty: Use gate, ball, and butterfly valves.

3.10 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use gate or ball valves; for sectional valves 2-1/2 inches and larger, use valves.

B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use valves; for shutoff valves 2-1/2 inches and larger, use valves.

C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use valves; for drain valves 2-1/2 inches and larger, use valves.

D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.

E. Hose Bibbs: Install on exposed piping where indicated with vacuum breaker.

F. Wall Hydrants: Install where indicated with vacuum breaker.

G. Point-of-Use Thermostatic Mixing Valve: Install valve complying with ASSE 1070 on all public lavatories and handwashing sink locations. Install valve to be accessible by maintenance staff. Set temperature limit to 110F for dual temperature faucet or 100F for single temperature faucet."

3.11 INSTALLATION OF AUTOMATIC FLOW CONTROL VALVES

A. Install automatic flow control valves in each hot water recirculating loop, and elsewhere as indicated. Install a shutoff valve and strainer upstream and a union, check valve and shutoff valve downstream of each automatic flow control valve.

B. Set automatic flow control valve flow rate as follows:

1. Provide valve body size as indicated on the drawings.

2. Provide constant flow cartridge with flow rate as indicated on the drawings.

C. Reports: Prepare hot water return system balancing reports signed and submit to the Architect upon completion of the project. Include the following information:

a) Valve tag number and description of location

b) Valve body size

c) Constant flow cartridge flow rate

3.12 TRAP PRIMERS

A. Install trap primers where indicated and where required by local authorities having jurisdiction.

B. Connect trap primer supply line to the top of domestic cold water line no larger than 1-1/2" in diameter.

C. Provide trap primer distribution units for trap primers serving more than one trap.

D. Install trap primer distribution level to insure even water distribution unit to each circuit.

E. Where applicable, adjust the trap primer for proper flow.

F. Install trap primers a minimum of 12 inches above finished floor for every 20 feet of horizontal outlet piping to floor drains served.

G. Install trap primers in an accessible location.

H. Refer to Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for trap primer outlet pipe requirements.

3.13 INSTALLATION OF PIPING SPECIALTIES

A. Install backflow preventers at each connection to mechanical equipment and systems and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain.

3.14 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each

connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

3.15 FIELD QUALITY CONTROL

A. Inspections: Inspect water distribution piping as follows:

1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

a) Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.

b) Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.

c) Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.

d) Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.

B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.

4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.

5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

C. Super Flush Test:

1. Purpose:

a) This test is designed to closely simulate the usage of the domestic water system at a high usage event such as halftime. The test shall verify adequate residual water pressure is present and is sized for such an event. Great care shall be taken not to "over simulate" the halftime event by flushing fixtures at a more rapid rate than what can realistically occur.

2. Procedure:

a) Fixtures to be tested: Water closets and urinals in the public restrooms on the Event, Club, Main Concourse, Suite, Press, and Upper Concourse levels.

b) Duration: 10 minutes.

c) Flushing frequency:

1) Water Closets: Flush every water closet in a restroom every 90 seconds.

2) Urinals: Flush every urinal in a restroom every 30 seconds.

3) At a minimum, provide (1) person per each (3) water closets or urinals to perform the test.

4) At the start of the test, flush no more than two water closets and two urinals simultaneously.

3. Timing: Notify Architect a minimum of one week in advance of the test.

4. Report: Provide pressure gauge at most remote/highest elevation toilet room hose bibbs at each water pressure zone (boosted and non-boosted). Provide video of hose bibb pressure gauges and booster pump control panel to indicate peak flow rate, booster pump discharge and suction pressures and number of pumps running. Contractors option, record booster pump suction pressure, flow rate and discharge header pressure digitally thru booster pump computer interface.

3.16 ADJUSTING AND CLEANING

A. Clean and disinfect water distribution piping as follows:

1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.

2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:

   a) Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.

   b) Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.

   c) Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.

   d) Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.

   e) Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

3.17 COMMISSIONING

A. Fill the system. Check compression tanks to determine that they are not air bound and that the system is completely full of water.

B. Before operating the system, perform these steps:

   1. Close drain valve, hydrants, and hose bibbs.

   2. Open valves to full open position.

   3. Remove and clean strainers.

   4. Check pumps for proper direction of rotation. Correct improper wiring.

   5. Lubricate pump motors and bearings.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section only applies to Mechanically Joined Plumbing Piping Systems for joining piping for Plumbing applications as defined in Division Section 22 “Water Distribution Piping and Specialties”. Section includes:

1. Copper grooved piping system
2. Copper press piping systems

B. The Division 22 contractor may provide mechanically joined, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods.

C. Mechanically joined couplings, fittings, valves and related components specified in this section shall not be provided for natural gas piping in lieu of welded, threaded or flanged piping methods.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.03 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

B. CWP: Cold working pressure in psi.

C. CTS: Copper tube size.

1.04 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 22 section “Basic Plumbing Piping Materials and Methods” for materials for dielectric waterway fittings and flange kits.

B. Division 22 Section “Water Distribution Piping and Specialties” for related sections.

1.05 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Submit data for each type of coupling, fitting and special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing.

C. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

1. Indicate grooved-joint couplings and fittings on drawings and product submittals, and specifically identify with the applicable style or series designation.

2. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.

D. Maintenance Data: Include for each piping specialty and valve in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

E. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

F. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 22 section “Basic Plumbing Piping Materials and Methods”.

G. Submit certification that valves and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

H. Submit certification that pipe, pipe fittings, pipe specialties, and valves and fittings are manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

I. Submit contractor certificates indicating completion of installation training course from manufacturer of piping to be used.

1.06 QUALITY ASSURANCE

A. All mechanically joined piping components shall be of one manufacturer, be date and origin stamped for quality assurance and traceability.

B. Grooved mechanical piping shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-39.1, ASME, UL/ULC, FM, IAPMO or ICC.

1. Components shall be capable of providing system rigidity to accommodate hanging and support in accordance with ANSI B31.1 and ANSI B31.9.

C. Mechanically joined piping component end product manufacturer shall be ISO certified.

D. Grooved couplings shall meet the requirements of ASTM F-1476.

E. Grooving tools shall be of an approved manufacturer by the grooved fittings manufacturer. Verify tolerances of and maintain grooving tool components for duration of grooving processes. Replace grooving tool components that are found out of tolerance with new as required.

F. Obtain training from the grooved and press to connect manufacturer for all workers that will be installing or handling the grooved or press to connect piping systems.

G. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves and fittings containing no more than 0.25% lead by weight for domestic water distribution.

H. Pipe, fittings, specialties, and valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI, and MSS standards.

1. Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

2. Obtain installation training from the mechanically joined piping manufacturer for all workers that will be installing or handling the mechanically joined piping components per Part III “FIELD QUALITY CONTROL” below. Maintain a copy of each worker’s training certificate of completion on site for the duration of the project.

1.07 COORDINATION

A. Reference Division 22 Section “Water Distribution Piping and Specialties” for coordination.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division 22 Section "Basic Pluming Piping Materials and Methods."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Refer to manufacturer's current literature for comparable products and pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules. Products identified by model number are based on available size ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.

B. Copper Grooved Copper Tubing System

1. ASC Engineered Solutions "Gruvlok".
2. Shurjoint Piping Products.
3. Victaulic Company of America.

C. Press to Connect Copper Tubing System

1. Apollo "XPress"
2. GRINNELL Mechanical Products "G-Press"
3. Mueller Streamline PRS
4. NIBCO Inc., Press System.
5. Viega ProPress

2.02 COPPER GROOVED TUBING SYSTEM

A. Pipe:

1. 2 inch through 8 inch: CTS, ASTM B88 Type K or L, hard drawn.
2. Ends: Roll grooved only in accordance to manufacturer's current listed standards. Flaring of tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.
3. Grooved mechanical piping shall conform to local code approval and/or as listed by ANSI-B31.9 "Building Services Piping," ASME, UL/ULC, FM, IAPMO or ICC.
    a) Components shall be capable of providing system rigidity to accommodate hanging and support in accordance with ANSI B31.9.

B. General requirements for couplings, adapters, and standard fittings:

1. Full-flow type, compatible with ASTM B75 or B88 CTS grooved joints.
2. Flaring of tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

C. Couplings:

1. Meeting ASTM F1476 and constructed of two-piece housing attached with bolts and nuts with pressure responsive elastomeric gasket, with pressure rating of 300 PSI at 180F. Provide washers where required by the manufacturer.
2. Material: Cast of ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15, coated with suitable enamel or epoxy.
3. Constructed of two-piece housing attached with bolts and nuts with pressure responsive elastomeric gasket, with pressure rating of 300 PSI at 180F. Provide washers where required by the manufacturer.
4. Rigid Type:
    a) ASC Engineered Solutions Gruvlok Series # 6402.
    b) Shurjoint Piping Products Styles #305, #306, and #307.
    c) Victaulic Style # 607.
5. Bolts, nuts, and washers:
    a) Track-head bolts of heat treated carbon or manganese steel conforming to ASTM A183 or A449 with a minimum tensile strength of 110,000 psi.
    b) Heavy-duty hexagonal nuts conforming to ASTM A563, Grade B.
    c) Plated carbon steel flat washers conforming to ASTM F436.
    d) Zinc-electroplated conforming to ASTM B633.
    e) Type 304 or 316 stainless steel bolts and nuts conforming to ASTM A193, Grade B8/B8M, Class 2 or ASTM F593 and F594, Group 2, Condition CW.
    f) Type 304 or 316 stainless steel washers.

D. Flange Adapters:
1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).
2. Material: Cast of ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15, coated with suitable enamel or epoxy.
3. 2 inch-6 inch (ANSI class 125/150):
    a) ASC Engineered Solutions Gruvlok Series # 6084.
    b) Shurjoint Piping Products Styles # C341.
    c) Victaulic Style # 641.

E. Fittings:
1. Materials:

a) Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.

b) Lead free bronze sand cast conforming to ASTM B584 alloy UNS C89836.

F. Gaskets:

1. EPDM Gaskets:

a) Grade “E”, “EHP” or “EHT” EPDM compound (green or red/green color coded, respectively) conforming to ASTM D2000 designation 2CA615A25B24F17Z.

b) Temperature operating range: -30 degrees F to +230 degrees F.

2. Fluoroelastomer Gaskets

a) Fluoroelastomer compound specifically formulated for compatibility with potable water systems resistant to chlorine and chloramine disinfectants (red and blue stripe color code).

b) Temperature operating range: 0 degrees F to +180 degrees F.

G. Valves:

1. Provide valves as specified in Division 22 section “General Duty Valves for Plumbing Piping.”

2. 2 Inch through 6 Inch Butterfly Valve:

a) 300 psig CWP, CTS grooved ends, MSS SP-68, suitable for bidirectional and dead-end service at full rated pressure. Conform to Class IV leakage requirements per FCI/ANSI 70-2.

b) Body: Lead free, cast brass to UNS C87850, C90500, or cast bronze per ASTM B584.

c) Disc: Aluminum bronze disc or elastomer encapsulated ductile iron disc per ASTM A536 Grade 65-45-12.

d) Stem: Stainless steel.

e) Seat: Pressure responsive and of a grade suitable for the intended service.

f) Operator: Lever operators (10 position minimum) with locks and stops. Provide chain wheel for valves installed 72 inches or higher above finished floor elevation in mechanical rooms. Extend chains to an elevation of 5’-0” above finished floor elevation.

g) Manufacturers:

1) ASC Engineered Solutions Gruvlok Series # 6700]

2) Shurjoint Piping Products Style # SJ-C300

3) ASC Engineered Solutions Gruvlok Series #B6700

4) Victaulic # 608N

H. Adapters – Grooved X Plain Copper

1. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100. CTS grooved end x plain end for press or sweat connection.

a) ASC Engineered Solutions Gruvlok Series #652

b) Shurjoint #C52

2.03 PRESS TO CONNECT COPPER TUBING SYSTEM

A. Copper Tube:

1. CTS ½inch through 4inch: ASTM B-88 Type K or L.

B. General requirements for couplings, adapters, and standard fittings:

1. Fittings shall meet ASTM F3226, ASME B16.51, ASME B31.9 and IAPMO PS-117 or ICC-ES IC 1002.

2. Acceptable body materials:

a) Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.

b) Lead free cast brass conforming to ASTM B584 alloy C87600.

3. Coupling and fitting housings with soldered ends shall conform to ASME B16.18 and B16.22.

4. Coupling and fitting housings with flared ends shall conform to ASME B16.26.

5. Coupling and fitting housings with threaded ends shall conform to ASME B1.20.1.

6. Coupling and fitting housings for press ends shall have self-contained O-ring seals in the coupling/fitting ends.

7. Rated for 200 psi CWP up to 250 degrees F maximum.

8. Press to connect fittings shall have leak feature integral to the fitting body to detect unpressed fittings during pressure testing.

C. O-Ring Seals: EPDM compound conforming to ASME B16.51, style suitable for the application.

D. Flange Adapters:

1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).

2. 2-1/2 inch through 4 inch (ANSI class 125/150):

a) Steel flange with NSF 14 compliant fused epoxy coating, copper or brass press to connect joint with copper face ring and plastic or rubber dielectric isolating ring separating the flange from the press to connect joint.

3. Rated for 200 psi CWP up to 250 degrees F maximum.

E. Valves:

1. Provide 2 inch and smaller press to connect valves listed in this section or lead free cast bronze valves 2 inch and smaller listed in Division 22 section "Water Distribution Piping and Specialties" may be used with sweat connections or sweat X press adapters.

2. Ball Valve, 2 inch and smaller: Meeting MSS SP 110, Class 150, 300-psi CWP at 250F; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof lead free brass stem and chrome-plated lead free brass ball, with replaceable TFE seats and seals, vinyl-covered steel handle and copper female press to connect ends. Manufacturers :

a) Apollo # 77WLF-A

b) NIBCO # PC-585-LF

c) Hammond # 8301A

d) Milwaukee # UPBA-450-12

3. Ball Valve , 2 inch and smaller: Meeting MSS SP 110, Class 150, 300-psi CWP at 250F; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof lead free brass stem and 316 stainless steel brass ball, with replaceable TFE seats and seals, vinyl-covered steel handle and copper female press to connect ends. Manufacturers:

a) Apollo # 77WCLF

b) NIBCO # PC-585-66-LF

c) Hammond # 8301A

d) Milwaukee # UPBA-450S-12

4. Gate Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body, solid wedge and bonnet of ASTM B 584 lead free cast bronze; brass packing gland and stem lead free brass; with non-asbestos composition packing, malleable iron handwheel and copper female press to connect ends. Manufacturers:

a) Apollo # 101T-PRLF

b) Hammond # UP645 P2

c) Milwaukee UP105 P2

d) NIBCO # PC-113-LF

5. Globe Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP; body, disc and screwed bonnet of ASTM B 584 lead free cast bronze; brass replaceable composition disc and lead free stem and brass packing gland, non-asbestos composition packing, malleable iron handwheel and copper female press to connect ends. Manufacturers:

   a) Apollo # 120T-PRLF

   b) Hammond # UP440 P2

   c) Milwaukee # UP502 P2

6. Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, lead free brass disc and disc holder and copper female press to connect ends. Provide valves capable of being reground while the valve remains in the line. Manufacturers:

   a) Apollo # 163T-PRLF

   b) Hammond # UP904 P2

   c) NIBCO # PF-413-Y-LF

   d) Milwaukee # UP509 P2

7. Lift Check Valves, 2-Inch and Smaller: Meeting MSS SP-139; 250-psi CWP, body, disc holder and cap of cast lead free bronze; horizontal or angle pattern, lift-type valve, with stainless steel spring, renewable "Teflon" disc and copper female press to connect ends. Provide valves capable of being refitted and ground while the valve remains in the line. Manufacturers:

   a) Apollo # 61LF

   b) Milwaukee # UP548T P2

8. Butterfly Valves – 2-1/2 inch and Larger

   a) MSS SP-67; 200-psi CWP; lug-type body constructed of ductile iron conforming to ASTM A 126, Class B or ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, [aluminum-bronze] [CF8M (316) stainless steel] disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks. Drill and tap valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required. Provide with factory installed press to connect flange adapters, as described herein, with bolts, nuts and washers.

F. Strainers:

1. Provide 2 inch and smaller press to connect strainers listed in this section or lead free cast bronze strainers 2 inch and smaller listed in Division 22

section “Basic Piping Materials and Methods” may be used with sweat connections or sweat X press adapters.

2. Strainers (Y pattern), 2” and smaller: Cast lead free bronze body and end cap with a pressure rating of 250 psi CWP at 250F, with screwed screen retainer with centered blowdown fitted with pipe plug, stainless steel mesh with 0.062” perforations and copper female press to connect ends. Manufacturer:

   a) Apollo # 59LF

PART 3 - EXECUTION

3.01 PIPING INSTALLATIONS

A. Install pipe, fittings, valves and specialties in accordance with manufacturer’s installation instructions.

B. Water distribution piping installations shall be installed subject to Division 22 Section “Water Distribution Systems and Specialties” in addition to those requirements specified in this Section.

C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

3.02 PIPE APPLICATIONS ABOVE GRADE

A. Water piping in sizes 2-1/2 to 8 inches shall be Type L drawn copper tube with roll-grooved ends and copper tube dimensioned mechanical couplings and fittings or water piping sizes 2-1/2 inch to 4 inch shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect fittings.

B. Water piping in sizes [2] [4] inches and smaller shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect copper couplings and fittings.

3.03 HANGERS AND SUPPORTS

A. Support of piping must account for expansion and contraction, vibration, and the dead load of the piping and its contents.

B. General: Hanger supports, and anchors devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping." Reference Division 22 Section “Water Distribution Systems and Specialties” for pipe spacing limitations.

3.04 PIPE JOINT CONSTRUCTION

A. Copper Grooved tubing System

1. Pipe ends shall be clean and free from oils, indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
2. Roll and cut groove ends in accordance to manufacturer's current listed standards. Use rolls sets designed and intended for use on the appropriate pipe material when grooving pipe.
3. Flaring of CTS tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.
4. Verify the gasket style and elastomeric material (grade) is suitable for the intended service as specified and in combination with any system chemical additive.
5. Reference latest published manufacturer's product data for additional pressure ratings and application information.
6. Reference latest published manufacturer's field installation instructions or other included installation instruction prior to attempting assembly.
7. Ream, deburr and clean tube ends and verify they are free from indentations, projections and roll marks in the area from tube end to groove for proper gasket sealing.
8. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) shall be of one manufacturer. All grooving tools shall be of one manufacturer, though not necessarily the same as the grooved component manufacturer.
9. Install gaskets with lubricant suitable for all piping services. Lubricant shall be by one manufacturer.

B. Press to connect Copper Tubing System

1. Ream, deburr and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.
2. Install permanent inspection mark on tube.
3. Clean tube and fittings of all dirt and oil. Verify O-ring is in place, press conntection components in place and free of oil, grease or dirt.
4. Push copper tube into fittings with twisting action to all the way to the fitting stop or shoulder.
5. Mark tube with permanent marker to indicate proper tube insertion depth.
6. Verify press tool has correct size jaw set for tube size used.
7. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.
8. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.

9. Squeeze jaw open to remove the tool and observe witness mark.

10. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.

11. Maintain minimum distance between joints per the manufacturer's published installation instructions.

12. Perform pressure test for unpressed fitting detection per manufacturer's installation instruction prior to final pressure test.

C. Dielectric Isolation Requirements for Copper Grooved Connections: Provide dielectric grooved waterway fittings or couplings at grooved galvanized steel, stainless steel or ductile iron to grooved copper joints. Dielectric waterway fittings are specified in Section "Basic Piping Materials and Methods".

D. Dielectric Isolation Requirements for Press to Connect Adapter Flange Connections: Provide dielectric flanges or flange kits for the following joint types:

1. Adapter Flanges to Iron, Ductile Iron or Steel Body Valves and Fittings (Except Butterfly Valves with EPDM Sleeve/Seats): Provide full face gaskets between flanges and adapter flanges. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.

2. Adapter Flanges to Butterfly Valves with EPDM Sleeve/Seats in Series with Iron, Ductile Iron or Steel Body Valves and Fittings: At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide steel bolts on butterfly valve flange.

3. Adapter Flanges to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.

4. Full face gaskets, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves are specified in Section "Basic Piping Materials and Methods".

E. Flange Adapters:

1. Install flange adapter washers when flange adapters are used against the following surfaces:

a) Rubber.

b) Adapting to ANSI/AWWA cast flanges.

c) Rubber faced lug valves.

d) Serrated flanged surfaces.

2. Do not install flange adapters for applications that incorporate tie rods for anchoring or on standard grooved-end fittings within 90 degrees of each other.

3.05 VALVE APPLICATIONS

A. Reference Division 22 Section “Water Distribution Piping and Specialties” for valve applications.

3.06 EQUIPMENT CONNECTIONS

A. Press to connect joints shall not be provided for equipment connections. Provide flanges, unions, di-electric unions or waterway fittings. Flanges, unions, di-electric unions and waterway fittings are specified in Division 22 specification section “Basic Piping Materials and Methods”

3.07 STRAINERS

A. Provide strainers as specified in part 2 of this specification section or Division 22 specification section “Basic Piping Materials and Methods”.

1. Provide manufacturer strainer with press to connect ends for 2 inches and smaller.
2. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.
3. Provide press to connect adapter flanges for 2-1/2 inches to 4 inches.
4. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

3.08 WATER DISTRIBUTION SPECIALTIES INSTALLATION

A. Reference Division 22 Section “Water Distribution Systems and Specialties” for water distribution specialties and installation requirements.

3.09 FIELD QUALITY CONTROL

A. The following procedures are paraphrased from the ASME B-31.9, code for pressure piping, building services piping.

B. Installing contractor shall schedule certification training session with the mechanically joined piping component manufacturer, or manufacturer's representative for all workers that will be installing or handling mechanically joined piping piping systems. Training shall cover the proper use of mechanically joining tools and installation of mechanically joined piping products.. Mechanically joined piping component manufacturer, or manufacturer’s representative shall provide a certificate of completion for each attending worker

C. Grooved and Press to connect fitting manufacturer shall provide certification training to contractor without cost and without additional cost to Owner.

D. Provide testing procedures as defined in Division 22 Section "Water Distribution Systems and Specialties" and as specified in mechanically joined piping component manufacturer's installation instructions.

E. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for inspection as defined in Division 22 Section "General Plumbing Requirements."

F. Mechanically joined piping component manufacturer's representative shall make periodic visits to the jobsite during construction to ensure the installing contractor is following the latest published manufacturer's field installation instructions and best practice procedures provided during the training session.

G. Workers performing mechanically joined joints shall initial each joint with a permanent ink marker, such as a "Sharpie". Initials shall be block letters with a minimum height of 1/4".

3.10 STARTUP

A. Refer to Division 22 Section "Water Distribution Piping and Specialties" for startup procedures.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:

1. Comply with NSF 14 for plastic potable-water-service piping.
2. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

PART 2 - PRODUCTS

2.1 JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.2 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:
   1. Description: Sleeve and valve compatible with drilling machine.
      a. Standard: MSS SP-60.
      b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
      c. Valve: AWWA, cast-iron, nonrising-stem, metal resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately **5 inches** in diameter.
   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for **NPS 3**and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves

and curb valves with ends compatible with piping, for **NPS 2** and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, **NPS 3**START_SIEND_SI and Larger: AWWA, cast-iron, nonrising-stem, resilient seated gate valves with valve box.
   2. Underground Valves, **NPS 4**START_SIEND_SI and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
   3. Use the following for valves in vaults and aboveground:
      a. Gate Valves, **NPS 2** and Smaller: Bronze, rising stem.
      b. Gate Valves, **NPS 3** and Larger: AWWA

3.2 PIPING SYSTEMS – COMMON REQUIREMENTS

A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

3.3 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

B. Water-Main Connection-1: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Make connections larger than **NPS 2** with tapping machine according to the following:
   1. Install tapping sleeve and tapping valve according to MSS SP-60.
   2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
   3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
   4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

D. Make connections **NPS 2** and smaller with drilling machine according to the following:
   1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
   2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
   3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
   4. Install corporation valves into service-saddle assemblies.
   5. Install manifold for multiple taps in water main.
   6. Install curb valve in water-service piping with head pointing up and with service box.

E. Comply with NFPA 24 for fire-service-main piping materials and installation.
   1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

G. Install PE pipe according to ASTM D 2774 and ASTM F 645.

H. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

I. Bury piping with depth of cover over top at least **30 inches**, with top at least **12 inches** below level of maximum frost penetration.

J. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
   1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

K. Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

L. Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

M. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

N. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   3. Set-screw mechanical retainer glands.
   4. Bolted flanged joints.
   5. Heat-fused joints.
   6. Pipe clamps and tie rods.

O. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
   3. Fire-Service-Main Piping: According to NFPA 24.

P. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.4 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

C. MSS Valves: Install as component of connected piping system.

D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.5 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

B. Water Meters: Install displacement-type water meters, **NPS 2** and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

C. Water Meters-1: Install compound-type water meters, **NPS 3** and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.6 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support **NPS 2-1/2** and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.7 WATER METER BOX INSTALLATION

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top **2 inches** above surface.

3.8 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

3.9 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install protective pipe bollards on two sides of each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
   1. Increase pressure in **50-psig** increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to **0 psig**. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is **2 quarts** per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

PART 1 -- GENERAL

1.01 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Cartridge type inline circulators
2. Time Switches

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.
3. Division 22 Section, “Basic Piping Materials and Methods” for rubber flexible connectors.
4. Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for inertia pads, isolation pads, spring supports, and spring hangers.
5. Division 23 Section “Direct-Digital Control for HVAC” for interlock of alarms with building automation system and alarm wiring.
6. Division 26 Section “Common Work Results for Electrical” required electrical devices.
7. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
2. Shop drawings showing layout and connections for plumbing pumps. Include setting drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
3. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.

4. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Submit certification that pumps, valves, fittings and specialties comply with NSF 61 Annex G.

6. Submit certificate to the Architect stating completion of factory start up and of proper booster pump installation per “startup” in Part III below:

1.03 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Plumbing pumps shall be listed and labeled by UL and comply UL Standard 778 "Motor Operated Water Pumps."

D. UL Compliance: Control panels shall be listed and labeled by UL and comply with Standard 508A “Control Panels”.

E. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

F. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

H. Comply with NSF 61 Annex G (pending) for wetted surfaces of valves, fittings and specialties containing no more than 0.25% lead by weight compliance for valves for domestic water service.

I. Valves, pumps and fittings shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

1.04 SPARE PARTS

A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump.

1.05 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Cartridge Type Inline Circulators:
   a) Armstrong Pumps, Inc.
   b) Bell & Gossett, ITT.
   c) Grundfos Pumps, Corp.
   d) Taco, Inc.
2. Aquastats:
   a) Dayton
   b) Honeywell
   c) Penn
   d) White-Rodgers
3. Time Switches
   a) Intermatic.com
   b) NSI Industries “TORK Series”

2.02 PUMPS, GENERAL

A. Pumps and circulators: factory assembled and factory tested.

B. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Motors: Conform to NEMA standards; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-

overload protection and grease-lubricated ball bearings. Select motors that are nonoverloading within the full range of the pump performance curve.

D. Apply factory finish paint to assembled, tested units prior to shipping.

2.03 CARTRIDGE TYPE CIRCULATOR PUMPS

A. General Description: Leakproof, inline, seamless, volute-type pump. Pump and motor shall be assembled on a common shaft in a single hermetically sealed unit, without stuffing boxes or mechanical seals. Accomplish sleeve bearings lubrication by circulating pumped liquid through the motor section. Isolate motor section from the motor stator windings with a thin corrosion- resistant, nonmagnetic, alloy liner. Pumps shall be rated for 125 psig working pressure and 225 degrees Fahrenheit continuous water temperature.

B. Casings: Cast lead free bronze, with stainless steel liner and static O-ring seal to separate motor section from motor stator, and with union piping connections.

C. Impeller: Overhung, single-suction, closed or open nonmetallic impeller.

D. Pump Shaft and Sleeve: Stainless steel shaft with carbon steel bearing sleeve.

E. Motors: 1750 RPM one piece sealed type.

2.04 AQUASTATS:

A. Remote sensing bulb type, non-modulating, single pole double pole throw with surface mount sensing bulb and mounting bracket, adjustable direct reading scale for set point with adjustable differential.

2.05 TIME SWITCHES

A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged, nickel-cadmium battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

B. Solid state programmable time control with owner designated quantity of separate programs, 24 hour battery carry over, duty cycling, individual on/off/auto switches for each program, 7 day programming, 365 day calendar with 20 programmable holidays.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pumps in accordance with manufacturer’s installation instructions.

B. General: Comply with the manufacturer's written installation and alignment instructions.

C. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

D. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

3.02 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.03 CONCRETE EQUIPMENT BASES

A. Refer to Division 22 Section “Basic Mechanical Materials and Methods” for concrete equipment bases.

1. Form concrete equipment bases by using framing lumber with form release compounds. Chamfer top edge and corners of pad.
2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.
3. Place concrete and allow to cure before installation of pumps.

3.04 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."

B. After alignment is correct, tighten the foundation bolts evenly but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

1. Alignment tolerances shall meet manufacturers recommendations.

3.05 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

C. Install a nonslam check valve and shutoff valve on the discharge side of pumps.

D. Install pressure gauges on the suction and discharge of each pump at the integral pressure gauge tappings provided.

E. Electrical wiring and connections are specified in Division 26 section “Common Work Results for Electrical”.

3.06 FIELD QUALITY CONTROL

A. Check suction lines connections for tightness to avoid drawing air into the pump.

3.07 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
2. Open the valve in the cooling water supply to the bearings where applicable.
3. Open the sealing liquid supply valve if the pump is so fitted.
4. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.
5. Open the recirculating line valve if the pump should not be operated against dead shutoff.
6. Start motor.

7. Open the discharge valve slowly.

8. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

9. Check the general mechanical operation of the pump and motor.

10. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same except that the discharge gate valve is opened some time before the motor is started.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
3. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
5. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
6. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.02 DEFINITIONS

A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping
2. No-hub fitting restraints
3. Drainage piping specialties
4. Trench drains
5. Interceptors

C. Test reports specified in Part 3 of this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cast Iron Soil Pipe and Fittings
2. Hubless Couplings:
   a) Anaco
   b) Ideal Tridon
   c) Mifab Manufacturing, Inc. #MI-HUB- series
   d) Mission Rubber Company
   e) ProFlo “PFNH”
   f) Tyler Pipe / Soil Pipe Division
3. Heavy Duty Hubless Couplings
   a) Anaco Husky HD-2000
   b) Clamp-All 80in. lb.
   c) Ideal Tridon “HD”
   d) Mifab Manufacturing, Inc. #MI-XHUB-series
   e) Mission Rubber Company, “Heavy Weight”
   f) ProFlo “HD”

4. Shielded Transition Couplings
    a) FERNCO, “Proflex 3000 Series”
    b) Anaco-Husky #SD-4200
    c) Mission Rubber Company, “Band Seal Specialty Couplings”
5. No-Hub Fitting Restraints
    a) Holdrite
6. Drainage Piping Specialties, including cleanouts, floor drains, cast-iron trench drains and vandal-proof vent caps:
    a) Jay R. Smith Mfg. Co.
    b) Josam Mfg. Co.
    c) Mifab Manufacturing Co.
    d) Sioux Chief Manufacturing Co. Inc.
    e) Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
    f) Watts Industries, Inc.
    g) Zurn Industries, Inc.; Hydromechanics Div.
7. Trap Seals
    a) Green Drain, Inc.
    b) Jay R. Smith Mfg. Co.
    c) Mifab Manufacturing, Inc.
    d) Proset Systems “Trap Guard”
    e) Rector Seal, Inc.
    f) Zurn Industries, Inc.; Hydromechanics Div.
8. Non-Metallic Trench Drains:
    a) ABT, Inc., Polydrain
    b) Dura Trench
    c) Jay R. Smith Mfg. Co.
    d) MEA-JOSAM
    e) Mifab Manufacturing Co.
    f) NDS
    g) Sioux Chief Manufacturing Co. Inc.
    h) Watts Industries, Inc.
    i) Zurn Industires, Inc.
9. Plastic Gravity Grease Interceptors

a) Green Turtle, Inc.

b) Mifab Manufacturing, Inc.

c) Schier Products

d) Thermaco, Inc.

e) Xerxes Corp.

2.02 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.

B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.

1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.

2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.

C. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

D. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

E. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.03 UNDERGROUND BUILDING DRAIN AND VENT PIPE AND FITTINGS

A. Refer to Part 3, Article "Pipe Applications - Below Ground, Within Building" for identification of systems where the materials listed below are used.

B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with “solid wall” PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.

2. Solvent: ASTM D2564.

C. PVC Pressure Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 with “solid wall” PVC meeting ASTM D1784 with cell class 12454.

1. Solvent: ASTM D2564.

2. Fittings: Schedule 40 meeting ASTM D2466 with solvent cement socket joints.

D. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.04 NO-HUB FITTING RESTRAINTS

A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

2.05 DRAINAGE PIPING SPECIALTIES

A. Cleanout Plugs: As specified on the drawings.

B. Floor Cleanouts: As specified on the drawings.

C. Wall Cleanouts: As specified on the drawings.

2.06 TRAP SEALS: PROVIDE TRAP SEALS MEETING EITHER DESCRIPTION BELOW:

2.07 TRENCH DRAINS

A. Trench drain type designations and sizes are indicated on the Drawings.

B. Non-Metallic Trench Drains: Polyester resin and quartz aggregate, precast, interlocking design, with bottom radius and 0.6 percent slope.

1. Precast Material: Load pressure of 14,500 psi, bending pressure of 2,900 psi, frost-proof, salt-proof, inert under dilute acid and alkali conditions, and less than 1.0 percent water absorption rate.

2. Grates: Cast iron or steel as indicated, for heavy-duty truck traffic, with openings designed to prevent entry of bicycle or wheelchair tires.

2.08 INTERCEPTORS

A. Interceptor type designations, flow rates, and capacities are indicated on the drawings.

B. Gravity Grease Interceptor: Reinforced precast concrete construction by local manufacturer or a plastic grease interceptor acceptable to the local authorities having jurisdiction.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.02 PREPARATION FOUNDATION FOR UNDERGROUND SANITARY BUILDING DRAINS

A. Pipe Beds:

1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

2. Cast Iron Soil Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation and maintain continuous pipe slope. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe, including fittings. After pressure testing is complete, install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.03 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.

B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.

C. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with ¾" minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger for waste connections from kitchen equipment and terminate over floor receptors with air gap.

D. Condensate drain piping and pumped condensate drain piping inside the building: Provide ¾" minimum size or as indicated on the drawings. Slope gravity drainage condensate piping from mechanical equipment at 1/8" per foot minimum slope. Discharge to floor receptor with air gap.

1. Install Type M copper tube with wrought copper fittings with solder joints, 1” and smaller and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4” and larger. Provide galvanic isolators as specified in Division 22 “Basic Piping Materials and Methods”.

E. Install galvanized schedule 40 steel pipe and malleable iron fittings for sump pump discharge pipe.

3.04 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings 15” and smaller for soil, waste and vent pipe.

B. Install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe for 24” and smaller. Install fabricated fittings for 16 inch and larger.

3.05 PIPE AND TUBE JOINT CONSTRUCTION

A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."

B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:

1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
2. Install hubless couplings complying with CISPI 310 on and soil and waste piping 3” and smaller and all vent piping.
3. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4” and larger.
4. Install No-Hub fitting restraints on joints 5” and larger at:
   a) Changes of direction from vertical to horizontal
   b) 4” branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5” and larger
   c) Horizontal changes of direction 22-1/2 degrees and greater
   d) Changes in diameter of two pipe sizes or greater.

C. Install heavy duty hubless couplings on hubless soil, waste and vent piping ping below floor.

3.06 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping

systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section " Basic Piping Material and Methods" for special sealers and materials.

H. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

I. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

3.07 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in

Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
    a) Install high density insulation on insulated pipe.
4. Provide vinyl coated hangers and riser clamps for use with PVC pipe and CPVC CTS tube.
5. Provide roll hangers for individual horizontal runs 100 feet or longer.
6. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.

C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14 to 15	12	N/A	3/4

D. Sway bracing:

1. Provide rigid sway bracing for pipe 4" and larger at changes of direction greater than 45 degrees.

E. Bracing:

1. Provide horizontal bracing for pipe 4" and larger at intervals not to exceed 40'.

F. Bracing for above floor base of stacks 4" and larger and higher than three stories:

1. Secure horizontal base of stack to structure with riser clamp within at the fitting changing direction of flow from vertical to horizontal. Provide rods of size equal to cast iron pipe size scheduled above in pipe hanger schedule.

3.08 INSTALLATION OF PIPING SPECIALTIES

A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
4. at base of each vertical soil and waste stack.

B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.

C. Floor Cleanouts: Install in below floor building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

3.09 INSTALLATION OF FLOOR DRAINS, FLOOR SINKS AND FLOOR TROUGHS

A. Install floor drains, floor sinks, shower linear trench drains and floor troughs in locations indicated.

B. Install floor drains, trench drains and shower linear trench drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Set floor sinks and floor troughs flush with the level finish floor.

C. Refer to architectural documents for floor slope requirements and set floor drain elevation to match. Where architectural documents do not indicate the requirements, set the floor drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

DEPRESSION IN INCHES	RADIUS OF AREA DRAINED - FEET
1/2	5

3/4	10
1	15
1-1/4	20
1-1/2	25

D. Provide P-traps for drains connected to the sanitary sewer.

E. Install floor drains, floor sinks, shower linear trench drains, and floor troughs in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION TRAP SEALS:

A. Install trap seals in accordance with manufacturer's written instructions and in locations indicated.

B. Make watertight seal using an adhesive type caulk along bottom of trap seal, if required by the manufacturer.

C. Employ a test plug for testing and remove before normal floor drain use. Clean inside of drain tailpiece and install trap seal after testing.

D. Do not touch elastomeric plug or allow contact with primer or solvent cement.

3.11 CONNECTIONS

A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.12 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

a) Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

b) Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

c) Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.

d) Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1” water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.

5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.13 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.14 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Nonpressure-type transition couplings.
4. Pressure-type pipe couplings.
5. Expansion joints and deflection fittings.
6. Backwater valves.
7. Cleanouts.
8. Encasement for piping.
9. Manholes.
10. Concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
1. Show system piping in profile. Draw profiles to horizontal scale of not less than **1 inch equals 50 feet** and to vertical scale of not less than **1 inch equals 5 feet**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 2 percent unless otherwise indicated.
   2. Install piping **NPS 6** and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   3. Install piping with **48-inch** minimum cover.
   4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   6. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
   7. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105/A21.5:
   1. Hub-and-spigot, cast-iron soil pipe.
   2. Hubless cast-iron soil pipe and fittings.
   3. Expansion joints and deflection fittings.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.2 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in

pavements. Set tops **3 inches** above finished surface elsewhere unless otherwise indicated.

3.3 BACKWATER VALVE INSTALLATION

A. Install horizontal-type backwater valves in piping manholes or pits.

B. Install combination horizontal and manual gate-type valves in piping and in manholes.

C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, **18 by 18 by 12 inches** deep. Set with tops **1 inch** above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   1. Close open ends of piping with at least **8-inch-** thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
   1. Remove manhole and close open ends of remaining piping.
   2. Remove top of manhole down to at least **36 inches** below final grade. Fill to within **12 inches** of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Section 312000 "Earth Moving."

3.6 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches** of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Fill sewer piping with water. Test with pressure of at least **10-foot** head of water, and maintain such pressure without leakage for at least 15 minutes.
      b. Close openings in system and fill with water.
      c. Purge air and refill with water.
      d. Disconnect water supply.
      e. Test and inspect joints for leaks.
   6. Manholes: Perform hydraulic test according to **ASTM C 969**

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Condensate pumps for HVAC equipment

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.
2. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties” for condensate pipe material and installation requirements.
3. Division 23 Section “Direct-Digital Control for HVAC” for interlock with HVAC equipment and interlock of alarms with building automation system and alarm wiring.
4. Division 26 Section “Common Work Results for Electrical” required electrical devices.
5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
2. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.
3. Maintenance data for condensate pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.03 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install condensate pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Plenum rated condensate pumps shall be listed and labeled by UL and comply with Standard 2043 “Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air Handling Spaces”.

D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

E. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

F. Design Criteria: The Drawings indicate capacity, connections, and power requirements of condensate pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

1.04 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Plenum Rated HVAC Condensate Pump:

a) Little Giant with no substitutions

2.02 PUMPS, GENERAL

A. Condensate Pumps: Factory assembled and factory tested.

B. Preparation for shipping: Provide suitable packaging to protect pump from damage during shipping.

2.03 CONDENSATE PUMPS FOR HVAC EQUIPMENT

A. General Description: Pumps shall be direct connected, single stage type with body and reservoir of a material suitable for plenum or non-plenum installation as

scheduled on plans, normally open safety overflow switch with two dry contacts, integral check valve and power cord with ground.

B. Plenum rated: Reservoir and body shall be all polypropylene and meet UL 2043.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's installation instructions.

B. Install pumps in locations and arrange to provide access for periodic maintenance.

C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

3.02 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.03 CONNECTIONS

A. Piping between the HVAC unit and the pump shall be the greater of the discharge port size on the HVAC equipment or 3/4" pipe size or as shown on plans, whichever is larger. Discharge piping from the condensate pump shall be equal to or greater than the diameter of the pump nozzle, minimum 3/4", or as shown plans, whichever is larger. Condensate pump discharge pipe material is specified in Division 22 Section "Sanitary Drainage and Vent Piping and Specialties".

B. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

C. Coordinate interlock of condensate pump safety overflow switch with unit served to disable unit if safety overflow switch closes as noted on plans and schedules. HVAC interlock wiring and alarm interlock with the building automation system are specified in Division 23 Section "Direct-Digital Control for HVAC".

3.04 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Ensure pump is connected to the condensate discharge system.

2. Verify all power wiring is in place and power is provided to pump.

B. Testing procedure for condensate pumps:

1. Pour water into the pump reservoir until the water sensing switch is activated.

2. Verify water is pumped out of the reservoir and that there are no leaks in the condensate piping or at the connection point to the pump.

3. Verify integral check valve is operating properly, replace with new if found to be defective.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes building storm drainage piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
3. Division 22 Section "Identification for Plumbing Piping and Equipment," for labeling and identification of drainage piping.
4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage piping.
7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.02 DEFINITIONS

A. Storm Building Drain: That part of the lowest piping of a drainage system which receives the discharge from storm drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Storm Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer or private sewer or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys storm water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping
2. Drainage piping specialties
3. Area drains

C. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

A. Comply with the installation requirements for PVC gasketed sewer pipe per the Uni-Bell PVC Pipe Association "Installation Guide for Solid Wall PVC Sewer Pipe". Comply with the installation requirements for gasketed fittings per the Uni-Bell PVC Pipe Association "Installation Guide for PVC Fittings and Laterals for Solid Wall PVC Sewer Pipe".

B. Obtain installation training from the PVC gasketed sewer pipe manufacturer for all workers that will be installing or handling the PVC gasketed sewer pipe piping systems. Submit certification letter along with each workers certificate of completion to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, area/roof drains, cast-iron trench drains and downspout nozzles:
   a) Josam Mfg. Co.
   b) Sioux Chief Manufacturing Co. Inc.
   c) Smith (Jay R) Mfg. Co.
   d) Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
   e) Watts Industries, Inc.
   f) Zurn Industries, Inc.; Hydromechanics Div.
   g) Mifab Manufacturing, Inc.
2. Heavy Duty Hubless Couplings
   a) Anaco Husky HD-2000
   b) Clamp-All 80in. lb.
   c) Ideal Tridon "HD"

d) Mifab Manufacturing, Inc. #MI-XHUB-series

e) Mission Rubber Company “Heavyweight”

f) ProFlo “HD”

3. Cast Iron Soil Pipe and Fittings

a) AB & I Foundry

b) Charlotte Pipe and Foundry Company

c) Tyler Pipe / Soil Pipe Division

4. Shielded Transition Couplings

a) FERNCO, “Proflex 3000 Series”

b) Anaco-Husky #SD4200

c) Mission Rubber Company, “Band Seal Specialty Couplings”

2.02 ABOVE GROUND DRAINAGE PIPE AND FITTINGS

A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.

B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings, and bearing the trademark of CISPI and NSF.

1. Heavy duty couplings and compression gaskets: ASTM C564, ASTM C1540 and meeting FM 1680.

C. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.03 UNDERGROUND BUILDING DRAIN PIPE AND FITTINGS

A. Refer to Part 3, Article "Pipe Applications - Below Ground, Within Building" for identification of systems where the materials listed below are used.

B. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings, and bearing the trademark of CISPI and NSF. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.

1. Neoprene Compression Gaskets: ASTM C564.

C. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings and bearing the trademark of CISPI and NSF.

1. Heavy-Duty couplings and compression gaskets: ASTM C564, ASTM C1540 and FM 1680.

D. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with “solid wall” PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.

2. Solvent: ASTM D2564.

2.04 DRAINAGE PIPING SPECIALTIES

A. Cleanout Plugs: As specified on the drawings.

B. Floor Cleanouts: As specified on the drawings.

C. Wall Cleanouts: As specified on the drawings.

D. Area drains: As specified on the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.02 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

A. Pipe Beds:

1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

2. Cast Iron Soil Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation and maintain continuous pipe slope. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe, including fittings. After pressure testing is complete, install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.03 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings 15" and smaller for storm pipe.

3.04 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

A. Install hub-and-spigot, service weight, cast-iron, soil pipe and fittings with gasketed joints for 15 inch and smaller storm pipe.

B. Install hubless, cast-iron soil pipe and fittings 15” and smaller for storm pipe.

C. Install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger.

3.05 PIPE AND TUBE JOINT CONSTRUCTION

A. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:

1. Install heavy duty hubless couplings on storm drainage piping, including connections to roof drains.

B. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.

3.06 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Materials and Methods” for special sealers and materials.

H. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

I. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

J. Make changes in direction for drainage piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

K. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger.

3.07 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
    a) Install high density insulation on insulated pipe.
4. Provide vinyl coated hangers and riser clamps for use with PVC pipe.
5. Provide roll hangers for individual horizontal runs 100 feet or longer.

C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for

horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size in Inches	Steep Pipe Max. Span in Feet	Copper Tube Max. Span in Feet	Min. Rod Dia - Inches
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 3	12	10	3/8
4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14	12	N/A	3/4
16	12	N/A	7/8

1. Support all sizes of hubless horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18”. Provide sway brace on horizontal piping at not more than 40’ intervals to prevent horizontal movement. Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support all sizes of vertical steel piping every other floor, not to exceed twenty-five feet.
4. Support all sizes of horizontal of PVC piping every four feet.
5. Support piping within 12” of each elbow or tee.

3.08 INSTALLATION OF PIPING SPECIALTIES

A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
4. at base of each vertical soil, waste, or storm water stack.

B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.

C. Floor Cleanouts: Install in below floor building drain piping as indicated and:.

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

3.09 INSTALLATION OF AREA DRAINS

A. Install area drains in locations indicated.

B. Install area drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Refer to architectural documents for floor slope requirements and set area drain elevation to match. Where architectural documents do not indicate the requirements, set the area drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

DEPRESSION IN INCHES	RADIUS OF AREA DRAINED - FEET
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

D. Provide P-traps for drains connected to combined sanitary and storm sewer.

E. Install area drains in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Position drains so that they are level, accessible and easy to maintain.

3.10 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation the storm drainage piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be

made. Perform tests specified below in the presence of the plumbing official.

a) Rough-in Inspection: Arrange for inspection of the storm drainage piping system before concealed or closed-in after system is roughed-in.

b) Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.

c) Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.

d) Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test storm drainage system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new storm drainage piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of storm drainage piping systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.11 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers and domes. Remove dirt and debris.

3.12 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

C. Exposed PVC Piping: Protect storm drainage piping exposed to sunlight with 2 coats of a water based latex paint.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Sump pumps

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for sump basins and covers.
2. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
3. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.
4. Division 22 Section “Storm Drainage Piping and Specialties” for sump pump discharge pipe material and installation requirements.
5. Division 23 Section “Direct-Digital Control for HVAC” for interlock of alarms with building automation system and alarm wiring.
6. Division 26 Section “Common Work Results for Electrical” required electrical devices.
7. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
2. Shop drawings showing layout and connections for plumbing pumps. Include setting drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
3. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.

4. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Shop drawings showing basins with depth, inlet, outlet and vent locations, pit covers, float switches, non-clog check valves and shutoff valves.

1.03 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Control panels shall be listed and labeled by UL and comply with Standard 508A “Control Panels”.

D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

E. SSPMA Compliance: Test and rate sump pumps in accordance with the Sump and Sewage Pump Manufacturers Association (SSPMA) Standards.

F. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

G. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:

1. MSS SP-72 “Ball Valves with Flanged or Butt Welding Ends”

2. MSS SP-110 “Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends”

H. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

I. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

1.04 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or

failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Elevator Pit Sump Pumps:
   a) ABS Pump, Inc.,
   b) FLYGT
   c) Weil Pump Company
2. Oil Sensing Sump Pump High Level Alarms
   a) Weil Pump Company
   b) SeeWater, Inc.
3. Full Port Bronze Ball Valves – 2" and smaller:

	MANUFACTURER	THREADED ENDS	SOLDER ENDS
a)	Apollo	77C-100	77C-200
b)	Hammond	8301A	8311A
c)	Milwaukee	BA-400	BA-450
d)	Nibco	T-585-70	S-585-70

4. Non-Clog "Flapper Type" Check Valves:
   a) Liberty Pumps "Series CVXXXC"
   b) Little Giant Pump Company "Series CV-SE"
   c) Zoeller Pump Company "Series 30"
5. Cast Iron "Sinking Ball Type" Non-Clog Check Valves - 2" and smaller:
   a) Flomatic "208"
   b) FLYGT "2002"
   c) GW Industries, Inc. "240T"
6. Basin Covers:
   a) Bilco
   b) U.S.F. Fabrication

2.02 PUMPS, GENERAL

A. Pumps: factory assembled and factory tested.

B. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Motors: Conform to NEMA standards; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve.

D. Apply factory finish paint to assembled, tested units prior to shipping.

2.03 ELEVATOR PIT SUMP PUMPS – ¾ HP AND SMALLER

A. General Description: Pumps shall be simplex centrifugal, direct connected, floor mounted, single stage type with cast iron body, stainless steel shaft, cast iron impeller, mechanical seal, permanently lubricated upper and lower ball bearings complete with integral inlet strainer, mechanical float switch, and power cord with ground.

B. Casing: Cast iron with integral cast-iron inlet strainer and legs to elevate the pump to permit flow into the impeller. Vertical discharge with screwed female connection.

C. Impeller: Statically and dynamically balanced, open or semiopen, overhung, single suction, fabricated from cast iron, keyed to shaft and secured by a locking capscrew.

D. Pump and Motor Shaft: Stainless steel, with factory-sealed, upper and lower grease-lubricated ball bearings.

E. Seals: Carbon steel rotating ring, stainless-steel spring, ceramic seat, and Buna-N bellows and gasket.

F. Motor: NEMA 6 with class F insulation, hermetically sealed, 1750 RPM, capacitor start, air filled with built-in overload protection, with 3-conductor, waterproof cable and grounding plug.

G. Controls: NEMA 1, tethered float switch for “on-off” control with “piggy back” power cord connection for sump pump power cord.

2.04 OIL SENSING SUMP PUMP ALARMS

A. Alarm Panel: Remote type 120V NEMA 3R panel, oil and water sensor, power cord, receptacle for pump power cord, 85 bd alarm horn, oil present alarm light, water present alarm light, high elev alarm light, silence switch, test switch and alarm contacts for each alarm condition.

1. Safeties:

a) High Level Alarm

1) When the water level rises to the level of “high level alarm” an audible alarm shall sound, an alarm light activate and alarm signal shall be sent to the BMS or local building alarm system.

b) Oil Present Alarm

1) When the sensor detects oil an audible alarm shall sound, an alarm light activate and alarm signal shall be sent to the BMS or local building alarm system.

c) Water Present Alarm

1) When the sensor detects water an audible alarm shall sound, an alarm light activate and alarm signal shall be sent to the BMS or local building alarm system.

2.05 BALL VALVES

A. Ball Valves, 2 Inch and Smaller: Meeting MSS SP-110, Class 150, 600-psi CWP; two-piece construction; with ASTM B584 cast bronze, full port, blowout-proof stem and chrome-plated brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder or threaded ends and vinyl-covered steel handle.

2.06 CHECK VALVES

A. Non Clog “Flapper Type” Check Valves, 2 Inch and Smaller: Flapper type with PVC body compression end fittings with Buna-N “O” ring and Buna-N flapper with PVC shields.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s installation instructions.

B. General: Comply with the manufacturer's written installation and alignment instructions.

C. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

D. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

E. Basins: Install sump pump basins in indicated locations and connect to drainage lines. Brace interior of basin in accordance with manufacturer's instructions to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work. Set cover over basin and fasten to top flange of basin. Install so cover is flush with finished floor.

3.02 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.03 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install discharge pipe sizes equal to or greater than the diameter of the pump nozzles. Sump pump discharge pipe material is specified in Division 22 Section "Storm Drainage Piping and Specialties".

C. Install a non-clog check valve in an accessible location or where indicated on the drawings. Install a full port ball valve on the discharge side of sump pumps downstream of the check valve.

D. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

3.04 FIELD QUALITY CONTROL

A. Pressure Testing: Perform a pressure test on the discharge assembly. The test pressure shall be twice that of the shut off head of the pump.

B. Valve Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.05 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
2. Start motor.
3. Open the discharge valve slowly.
4. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
5. Check the general mechanical operation of the pump and motor.

C. If the pump is to be started against a closed check valve with the discharge shut-off valve open, the steps are the same except that the discharge shut-off valve is opened some time before the motor is started.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes electric water heaters.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 22 Section “Common Work Results for Plumbing” for concrete equipment pads.
3. Division 22 Section "Basic Piping Materials and Methods" for pipe joining materials, unions, dielectric unions, dielectric flanges, dielectric flange kits and basic installation requirements.
4. Division 22 Section "Meters and Gauges for Plumbing Piping." for thermometers and their installation requirements.
5. Division 26 Section “Common Work Results for Electrical” required electrical devices.
6. Division 26 Section "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.
2. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
3. Certificates of shop inspection and data report as required by provisions of the ASME Boiler and Pressure Vessel Code.

4. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.03 QUALITY ASSURANCE

A. UL Standards: Provide water heaters complying with the following:

1. UL 174, "Household Electric Storage Tank Water Heaters."
2. UL 778, "Motor Operated Water Pumps."
3. UL 1453, "Electric Booster and Commercial Storage Tank Water Heaters."

B. NSF Standards: Provide water heaters complying with NSF No. 5, "Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dishwashing Machines," and bearing NSF label.

C. Electrical Component Standard: Provide components complying with NFPA 70 "National Electrical Code."

D. Listing and Labeling: Provide water heaters that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. ASME Code Compliance: Provide water heaters and safety relief valves that comply with ASME Boiler and Pressure Vessel Code and that bear the appropriate code symbols.

F. State Boiler Code Compliance: Provide rated water heaters, safety relief valve and accessories that comply with the state boiler code in effect.

G. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90.1b, "Energy Conservation in New Building Design."

H. Design Concept: The drawings indicate types and capacities of water heaters and are based on specific descriptions and manufacturers indicated. Water heaters having equal performance characteristics by other manufacturers may be considered provided that deviations in capacities, dimensions, operation, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of water heaters is on the proposer.

1.04 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, controls, tanks, and coils. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

1. Commercial Electric Water Heaters:

a) Tank: Three years

b) Controls and Other Components: One year

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Commercial Electric Water Heaters:

a) Bock Waters Heaters, Inc]

b) Bradford-White Corp.

c) Hubbel Water Heater

d) Lochinvar Water Heater Corp.

e) Rheem Mfg.

f) Ruud Mfg. Div of Rheem Mfg.

g) A.O. Smith Water Products Co. Div.; A.O. Smith Corp.

h) State Industries, Inc.

i) HTP Comfort Solutions, LLC

2. Thermal Expansion Tanks

a) Armstrong Pumps, Inc.

b) Amtrol, Inc.

c) Bell & Gosset, ITT

d) Elbi

e) TACO, Inc.

f) Watts

g) Wessels Tank Co.

3. Pressure Relief Valves

a) Apollo #16LF-202

b) Cash ACME #FW

c) Watts #LF53

d) Wilkins #P1520XL

2.02 ELECTRIC WATER HEATERS

A. Description: Automatic, commercial, electric; with vertical, 150-psig-rated storage tank, integral controls, drain valve, and relief valve.

B. Insulation: Fiberglass or polyurethane foam, surrounding tank.

C. Jacket: Steel, with baked-on enamel finish.

D. Tank: Glass-lined steel with anode rods and drain valve.

E. Heating Elements: Screw-in or flanged bolt-in immersion type, in multiples as described on the drawings.

F. Controls: Adjustable surface mounted thermostats.

G. Controls: Adjustable immersion thermostats.

H. Safety Controls: Automatic, high-temperature-limit cutoff.

I. Temperature and Pressure Relief Valve: Lead free brass body meeting ANSI Z21.22.

2.03 THERMAL EXPANSION TANKS

A. ASME Thermal Expansion Tanks: Provide size and number as indicated; construct of welded carbon steel ASME labeled for 150 psig working pressure, 200 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a FDA approved butyl rubber diaphragm securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

B. Thermal Expansion Tanks: Provide size and number as indicated; construct of welded carbon steel listed for 150 psig working pressure, 200 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a FDA approved butyl rubber diaphragm securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base.

2.04 PRESSURE RELIEF VALVES

A. Pressure Relief Valve: 1/2” lead free brass body meeting ANSI Z21.22 with screwed ends, stainless steel spring and factory set to relieve at 100 psig.

PART 3 - EXECUTION

3.01 WATER HEATER INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. General: Install water heaters on concrete equipment bases. Set and connect units in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.

C. Install thermometers on water heater outlet piping. Thermometers and their installation requirements, are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

D. Install temperature and pressure relief valve furnished with water heater. The temperature shall be normally set to relieve at 210F and the pressure relief shall be equal to the tank pressure rating. Install line size relief valve discharge line to discharge to an approved receptor with air gap.

E. Install pressure relief valve on cold water supply to water heater downstream of shutoff and check valves. The pressure relief shall be factory set to 100 psig. Install line size relief valve discharge line to discharge to an approved receptor with air gap.

3.02 CONCRETE EQUIPMENT BASES

A. Construct concrete equipment bases in accordance with Division 22 Section “Common Work Results for Plumbing” for concrete and setting of equipment.

3.03 EXPANSION TANK INSTALLATION

A. Charge expansion tank bladder with air to a pressure equal to the domestic water static pressure.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment arranged to allow servicing and maintenance.

2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.

a) Where water heater piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2” and smaller and install dielectric flanges for joints 2-1/2” and

larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."

b) Install vacuum relief valve in cold water inlet piping.

3. Install drain as indirect waste to spill into open drain or over floor drain.

a) Install drain valve at low point in water piping, for water heaters not having tank drain.

4. Install heat traps at inlet and outlet of each water heater storage tank. Heat trap shall be made of elbows and piping. Heat trap shall turn down to 12" below the outlet or inlet, run 12" horizontal and turn up to the cold water to the heater or hot water from the heater. Where multiple tanks are connected with a manifold, a single heat trap may be provided at the connection of the cold water supply to the cold water manifold together.

B. Electrical Connections:

1. Power wiring is specified in Division 26 Section "Common Work Results for Electrical"

2. Field-installed disconnects are specified in Division 26 Sections "Enclosed Switches and Circuit Breakers".

3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.05 FIELD QUALITY CONTROL

A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate operation of equipment as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

3.06 STARTUP

A. Perform the following before start-up final checks:

1. Fill water heaters with water.

2. Piping systems test complete.

3. Check for piping connections leaks.

4. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.

2. Adjust operating controls.

3. Adjust hot water outlet temperature setting.

3.07 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of [two] [four] [eight] hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Joint Sealers," for materials and methods for sealing between plumbing fixtures and interior walls.
2. Division 10 Section "Service Wall Systems" for wall modules with built-in plumbing fixtures.
3. Division 22 Section "General Duty Valves for Plumbing Piping" for valves used as supply stops.

C. Products furnished but not installed under this Section include:

1. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment provided by Owner.
2. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment specified in other Sections.

D. Products installed but not furnished under this Section include:

1. Owner furnished fixtures, as indicated.
2. Accessories, appliances, appurtenances, and equipment specified in other Sections, requiring plumbing services or fixture-related devices, as indicated.

1.02 DEFINITIONS

A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.

B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.

C. Appliance: Device or machine designed and intended to perform a specific function.

D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.

E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.

F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.

H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:

1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.
2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.

J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

K. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.
2. Wiring diagrams for field-installed wiring of electrically operated units.

3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

B. Submit third party certification that faucets and trim for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following faucets and trim need not comply:

1. Electronic faucets
2. Service sink faucets
3. Flush valves
4. Shower valves and heads

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of ANSIICC Standard A117.1, "Buildings and Facilities -- Providing “Accessibleility and Usable ility for Physically Handicapped PeopleBuildings and Facilities," Public Law 90-480, "Architectural Barriers Act, 1968," with respect to plumbing fixtures for the physically handicapped and "Americans with Disabilities Act Accessibility Guidelines for Buildings 2010 ADA Standards for Accessible Design”1991" with respect to plumbing fixtures for the physically handicappedindividuals with disabilities.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of faucets and trim containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.05 SPARE PARTS

A. Deliver spare parts to Owner. Furnish spare parts described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.

B. Water Closet Tank Repair Kits: Furnish quantity of identical flush valve units not less than 5 percent of amount of each type installed.

C. Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type toilet seat installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:

1. Water Closets:
   a) Kohler Co.
2. Urinals:
   a) Kohler Co.
3. Lavatories:
   a) American Standard, Inc.
   b) Kohler Co.
4. Sinks:
   a) Elkay Manufacturing Co.
5. Mop Basins:
   a) Acorn Engineering Co.
   b) Fiat Products.
   c) Stern-Williams Co., Inc.
6. Toilet Seats:
   a) Bemis Mfg. Co.
   b) Beneke Div.; Sanderson Plumbing Products, Inc.
   c) Church Seat Co.
   d) Kohler Co.
   e) Olsonite Corp.
   f) Sperzel Industries, Inc.
7. Flushometers – Diaphragm Type:
   a) Sloan Valve Co.
8. Commercial/Residential Cast-Brass and Cast-Brass Underbody Faucets:

a) Elkay Manufacturing Co.

b) Kohler Co.

9. Stop Valves & Supplies:

a) Brass Craft Subsidiary; Masco Co.

b) Engineered Brass Company

c) McGuire Manufacturing Co., Inc.

d) PROFLO

e) Watts Brass and Tubular

10. P-traps, Drains & Miscellaneous Fittings:

a) Brass Craft Subsidiary; Masco Co.

b) Dearborn Brass

c) Engineered Brass Company

d) Franke

e) McGuire Manufacturing Co., Inc.

f) PROFLO

g) Watts Brass and Tubular

h) Zurn Industries

11. Supports:

a) Josam Co.

b) Smith (Jay R.) Mfg. Co.

c) Wade Div.; Tyler Pipe.

d) Watts Drainage Products

e) Zurn Industries, Inc.; Hydromechanics Div.

f) Mifab Manufacturing, Inc.

12. Insulation Kits

a) Brocar

b) McGuire

c) Plumberex

d) PROFLO

e) Trap-Wrap

f) Truebro, Inc.

2.02 PLUMBING FIXTURES, GENERAL

A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified on the drawings and below:

2.03 FAUCETS

A. Faucets General: As described on the drawings.

1. Electronic faucets shall be of the same manufacturer as the water closet and urinal flush valves.

2.04 STOP VALVES & SUPPLIES

A. Supplies General: As described on the drawings.

1. Exposed piping and parts shall be polished chrome plated.

2.05 P-TRAPS, DRAINS AND MISCELLLANEOUS FITTINGS:

A. Fittings General: As described on the drawings, except as listed below.

1. Exposed piping and fittings shall be polished chrome plated.
2. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.
3. Fitting and faucet bodies for domestic water distribution shall be of lead free brass or lead free cast bronze.

B. Sink Continuous Wastes: Polished chrome-plated, tubular brass, 1-1/2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.

C. Scullery sink Continuous Wastes: Polished chrome-plated, tubular brass, 2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.

D. Bathtub Waste and Overflow Fittings: Concealed 1-1/2-inch, 17-gauge, polished chrome-plated, tubular brass; lever-operated pop-up bath waste and overflow, spud with universal-type outlet connection suitable for 1-1/2-inch tubing, or 1-1/2-inch solder-joint outlet connection on waste tee.

E. Escutcheons: Wall flange with set screw.

F. Escutcheons: Polished chrome-plated, sheet steel wall flange with friction clips.

G. Deep Pattern Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.06 FLUSHOMETERS

A. Provide flushometers compatible with fixtures, with features and of consumption indicated As described on the drawings.

1. Exposed metal parts shall be polished chrome plated.

2. Flush valves installed within wall construction may be without chrome plate finish.

2.07 TOILET SEATS

A. General: As described on the drawings.

2.08 PLUMBING FIXTURE SUPPORTS

A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.

B. Support categories are:

1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gauge with carriers for wall-hanging water closets.

2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.

3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.

4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.

C. Support Types: Provide support of category specified, of type having features required to match fixture.

D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

2.09 INSULATION KITS

A. Insulation kits for lavatory and sink waste and supplies of vinyl plastic with reusable fasteners and openings for access to supply stop handles.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install fixtures, trim and supports in accordance with manufacturer's installation instructions.

3.02 APPLICATION

A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:

3.03 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.

B. Fasten wall-mounted fittings to reinforcement built into walls.

C. Secure supplies behind wall or within wall pipe space, providing rigid installation.

D. Install stop valve in an accessible location in each water supply to each fixture.

E. Install trap on fixture outlet except for fixtures having integral trap.

F. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.

G. Install insulation kits on ADA compliant sink and lavatory waste, continuous wastes, hot and cold water supplies where indicated on the drawings and as required by the ADA.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.

2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.05 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.06 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.

D. Replace washers of leaking and dripping faucets and stops.

E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

F. Adjust faucet wrist blade handles perpendicular to the spout while in the closed position.

G. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

H. Set each shower valve temperature limit stop to 110ºF. Perform work after the shower head is installed and the domestic water heater is in operation. Allow the hot water to run for 5 minutes minimum or until temperature reaches equilibrium. Allow cold to run for 5 minutes minimum or until temperature reaches equilibrium. Provide the architect a report and schedule indicating the hot, cold and mixed maximum water temperature at each shower.

3.07 FIXTURE SCHEDULE

A. Provide plumbing fixtures as specified on the drawings.

B. Install rough-in for plumbing fixtures as scheduled on the drawings.

3.08 MOUNTING HEIGHTS SCHEDULE:

A. Refer to the architectural drawings for plumbing fixture mounting heights. Unless indicated otherwise, install plumbing fixtures with the mounting heights as listed below with final approval by the Architect:

FIXTURE	MOUNTING HEIGHT
Lavatory or Sink	
Standard Height	31" floor to rim
ADA Accessible	34" floor to rim
Child Height	24" floor to rim
Urinal	
Standard Height	24" floor to rim
ADA Accessible	17" floor to rim
Child Height	14" floor to rim
Water Closet	
Standard	15" floor to rim

ADA Accessible	17" to 19" floor to top of seat
Child Height	10" floor to rim
Water Cooler or Drinking Fountain	
Standard Height	41" floor to spout
ADA Accessible	36" floor to spout
Child Height	30" floor to spout
Shower Valves	
Standard Height	48" men and 42" women floor to centerline
ADA Accessible	38" minimum to 48" maximum floor to centerline
Shower Heads	
Standard Height	6'-6" men, 6'-0" women floor to centerline
Tub Valves	
Standard Height	32" floor to centerline
ADA Accessible	Center between grab bar and tub rim
Clinice Service Sinks	30" floor to rim
Surgeon's Scrub-up Sinks	35" floor to front rim
Ice Maker Outlet Boxes	24" floor to center of box
Washing Machine Outlet Boxes	42" floor to rim
Janitor's Sink Faucet Fittings	42" floor to center of box
Hose Bibbs	36" AFF to centerline
Non Freeze Wall Hydrant	18" AFG to centerline

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:

1. Pipes, fittings, and specialties.
2. Special duty valves.
3. Pressure regulators.
4. Service meters.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined joints for natural gas systems to connect couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, welded, threaded or flanged piping methods. Mechanically joined natural gas systems where used shall be provided in compliance with specification Section 227011 “Mechanically Joined Natural Gas Systems”.

C. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.

D. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General plumbing Requirements," for trenching, excavation, backfill and compaction materials and methods for underground piping installations.
2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.
3. Division 9 Section "Painting," for materials and methods for painting pipe.
4. Division 12 Section “Laboratory Casework and Fixtures,” for laboratory trim installed in the casework.
5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall and floor penetrations.

6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, unions, dielectric flanges, and mechanical sleeve seals.

7. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting gas distribution piping.

8. Division 26 Section “Common Work Results for Electrical” required electrical devices.

9. Division 23 Section “Direct-Digital Control for HVAC” for interlock of data and alarms with building automation system and control wiring.

10. Division 26 Section “Common Work Results for Electrical” required electrical devices.

11. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

E. Gas pressures for systems specified in this Section are limited to 5 psig.

F. Products furnished under this Section include gas meters and gas service piping, which will be provided by the utility company to the site. The following is the name and address of the utility company:

Contact: _____

Company: _____

Address: _____

Telephone number: (___) ___-____

1.02 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.

C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.

D. Point of Delivery: The outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.03 SUBMITTALS

A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Shop drawings detailing dimensions, required clearances, for connections to gas meter.

C. Coordination drawings for gas distribution piping systems in accordance with Division 22 Section "General Plumbing Requirements."

D. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

E. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

F. Test reports specified in Part 3 below.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."

C. Regulatory Requirements: Comply with the requirements of the following codes:

1. 2018 International Fuel Gas Code

D. Local Gas Utility Requirements: Comply with local gas utility installation rules and regulations.

E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.05 SPARE PARTS

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:

1. Gas Ball Valves – 2” and Smaller:
    a) Apollo Valves # 77F-1XX-01
    b) Hammond Valve # 8901
    c) Milwaukee Valve # BA-475B
    d) Nibco Inc. # T-FP 600A
    e) Watts # FBV-3C
2. Gas Ball Valves – 2-1/2” to 4”:
    a) Apollo Valve # 77F-1XX-01
    b) Hammond Valve # 8901
    c) Milwaukee Valve # BA-475B
    d) Nibco Inc. # T-FP 600A
3. Gas Cocks – 2” and Smaller:
    a) Homestead # 601
    b) Milliken #200M
    c) RM Energy Systems # D125
4. Gas Cocks – 2-1/2” and Larger:
    a) Homestead # 602
    b) Milliken #200MF
    c) RM Energy Systems “Hercules” # D126
5. Gas Pressure Regulators
    a) American Meter Company
    b) Fisher
    c) Itron
    d) Sensus
    e) Maxitrol
6. CSA Listed Gas Pressure Regulators
    a) Karl Dungs, Inc.
    b) Maxitrol
    c) Pietro-Fiorentini
7. Polyethylene to Steel Pipe Transition Fittings:
    a) Perfection Corporation
    b) R.W. Lyall
    c) Central Plastics
8. Insect Screens

a) Northtown Pipe Protection Products “BUGSCRN Series”

9. Gas Relief Vents

a) Richards “GV Series”

2.02 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the specified pipe and fitting materials listed below are used.

B. Steel Pipe: ASTM A 53, Grade B, Schedule 40, (Type E electric-resistance welded or Type S seamless, black steel pipe, beveled ends).

2.03 FITTINGS

A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

1. 1-1/4” and smaller shall be socket type

2. 1-1/2” and larger shall be butt weld type.

C. Forged Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, butt weld ends, standard pattern with bolts, nuts and gaskets of material group 1.1.

D. Transition Fittings – Steel to Polyethylene: Factory assembled and pressure tested one piece design, with steel half of Schedule 40 steel pipe with beveled edge for welding and polyethylene half shall be of ample length for making welds. Steel pipe shall have epoxy protective coating.

E. Insect screens: Black steel body with 20 mesh stainless steel screen and MNPT end.

F. Gas Relief Vents: Galvanized steel body with 90 degree inlet to screened outlet, 20 mesh stainless steel screen and FNPT end.

2.04 JOINING MATERIALS

A. Joint Compound: Suitable for the gas being handled.

B. Gasket Material: Thickness, material, and type suitable for gas to be handled, and for design temperatures and pressures.

2.05 VALVES

A. Gas Ball Valves – 2” and Smaller: Full port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 600 WOG, UL listed for natural gas service.

B. Gas Ball Valves – 2-1/2" to 4": Standard port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 400 WOG, UL listed for natural gas service.

C. Gas Cocks 2 Inch and Smaller: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body, brass or semi-steel plug with full area rectangular port, straightaway pattern, square head, threaded ends.

D. Gas Cocks 2-1/2 Inch and Larger: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body and plug with full area rectangular port, straightaway pattern, single gland, wrench operated, flanged ends.

E. Gas Line Pressure Regulators: Single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; internal relief vent, vent limiter for indoor installation, with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow as indicated on the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

3.02 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.03 PIPE APPLICATIONS

A. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.04 PIPING INSTALLATION

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: As specified below:

1. Inaccessible Above-Ceiling Locations: Install concealed gas piping in inaccessible above-ceiling spaces without valves or unions.

2. Accessible Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum. Valves and unions shall not be located in such spaces used as a plenum.

3. In Floors: Install concealed gas piping in concrete floor slabs in an air-tight conduit constructed of Schedule 40 PVC with socket weld joints two pipe sizes larger than the gas pipe served. Extend conduit a minimum of 12" above finish floor and cap air tight at both ends. Vent conduit to the outside with a minimum 2" pipe and terminate with a screened vent cap.

4. Piping In Partitions: Install concealed gas piping in hollow partitions with welded joint (subject to the approval of the authority having jurisdiction) and protect gas piping against physical damage. Install gas piping passing through partitions with no joints or unions inside the partition.

5. Concrete or Masonry Walls: Do not install gas piping in masonry or concrete walls.

6. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

E. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.

F. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 22 Section "Common Work Results for Plumbing" for additional information.

G. Dirt legs and Sediment Traps: Install a dirt leg at points where condensate and impurities may collect, at the outlet of the gas meter, as close to the inlet of each gas appliance or equipment as possible, and in a location readily accessible to permit cleaning and emptying.

1. Construct dirt legs and sediment traps using a tee fitting with the bottom outlet plugged or capped. Provide a 3" length of pipe and screwed cap for the dirt leg. Use line size pipe for dirt leg, refer to the drawings for sizes. Enter the tee with flow from the top and exit the tee from the side

outlet. Install the dirt leg a minimum of 3-1/2" above the roof or floor readily accessible to permit cleaning and emptying.

2. Install line size gas cock, union and dirt leg at each equipment connection; refer to the drawings for sizes. Provide reducers at the equipment connection as required. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

H. Use fittings for all changes in direction and all branch connections.

I. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

J. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

K. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

L. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Allow sufficient space above removable ceiling panels to allow for panel removal.

M. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

O. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

P. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

Q. Install unions in pipes 2 inch and smaller, adjacent to each valve, and elsewhere as indicated. Unions are not required on flanged devices. Unions are specified in Section "Basic Piping Materials and Methods".

R. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Dielectric unions and flanges are specified in Section "Basic Piping Materials and Methods".

S. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

T. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

U. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."

3.05 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for steel pipe 2-1/2" and larger for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

3. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual exposed runs on walls.

4. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube.

5. Provide roll hangers for individual horizontal runs 100 feet or longer.

6. Provide roll hangers for individual horizontal runs 20 feet or longer for exposed piping installed on roofs.

7. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58 and SP-69, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size in Inches	Max Span In Feet	Min. Rod Dia. - Inches
1/2	6	3/8
3/4 to 1	8	3/8
1-1/4 to 2	10	3/8
2-1/2 to 3	10	3/8
4	10	3/8
6	10	1/2
8	10	3/4

C. Support vertical piping at every floor.

D. Support gas piping within 12" of each elbow or tee and for gas piping 2-1/2" and larger at each valve or pressure regulator.

3.06 PIPE JOINT CONSTRUCTION

A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.
2. Align threads at point of assembly.
3. Apply thread compound for use with gas systems to the external pipe threads. Pipe thread tape is not accepted.
4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

D. Fusion Welded: Joints shall be made by a qualified and approved operator in accordance with Title 49, CFR, Part 192.283 and be made in accordance with pipe manufacturer's recommendations.

E. Semi-rigid Corrugated Stainless Steel Tubing: Joints shall be made by a qualified and approved operator in accordance with pipe manufacturer's recommendations.

3.07 VALVE APPLICATIONS

A. General: The Drawings indicate valve types, locations, and arrangements.

B. Shut-off duty: Use gas cocks specified in Part 2 above.

3.08 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Installation of Gas Pressure Regulators:

1. Install a gas cock 10 pipe diameters upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.
2. Install line pressure regulators a minimum of 10 pipe diameters upstream of each atmospheric or power burner equipment connection.
3. Install line pressure regulators a minimum of 10'-0" upstream of each condensing boiler or water heater connection.
4. Install gas pressure regulator relief devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.
5. Install gas pressure regulators with listed vent limiters indoors where allowed by the AHJ. Install with regulator dome vertically upright and level.
6. Install gas pressure regulators located outside the building with the relief port facing down to prevent the entry of moisture with the relief port a minimum of 18" above the roof or finish grade. Remove vent limiter and provide with line size (same size as gas vent relief port) insect screen or gas relief vent and 1" long schedule 40 black steel nipple.
    a) Where manufacturer does not allow the gas pressure regulator to be installed upside down, install gas pressure regulator with regulator dome in the horizontal or vertically upright with factory breather plug.
7. Gas Pressure Regulator Relief Vents: Provide for gas pressure regulators that require them or for vent less regulators where the AHJ requires them. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger. Route vent to the outdoors thru building side wall and turn down or thru the roof and turn down minimum 18" above the roof or grade. Provide with line size (same size as gas relief) insect screen or gas relief vent. Provide vent sizes per the following developed length and include 3 feet of length for each elbow:
    a) 10 feet developed length = size vent one pipe size larger than relief vent outlet size
    b) 20 feet developed length = size vent two pipe size larger than relief vent outlet size
    c) 30 feet developed length = size vent three pipe size larger than relief vent outlet size
    d) 40 feet developed length = size vent four pipe size larger than relief vent outlet size

3.09 TERMINAL EQUIPMENT CONNECTIONS

3.10 ELECTRICAL BONDING AND GROUNDING

A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes mechanically joined fittings and valves for distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:

1. Fittings.

B. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Natural Gas Systems," for valves, hangers, natural gas systems and installation requirements.

D. Gas pressures for systems specified in this Section are limited to 5 psig.

1.02 SUBMITTALS

A. Product data for each mechanically joined gas pipe fitting. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Maintenance data for mechanically joined gas pipe fittings, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

C. Installer qualification certificates, certifying that installers comply with the quality requirements specified under "Quality Assurance" below.

D. Test reports specified in Part 3 below.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Installation of mechanically joined fittings shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5

previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Local Gas Utility Requirements: Installation of mechanically joined fittings shall comply with local gas utility installation rules and regulations.

C. Mechanically joined fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

D. Obtain training from the mechanically joined fittings manufacturer for all workers that will be installing or handling the mechanically joined fittings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:

1. Mechanically Joined Fittings:

a) Viega “Mega-Press G Fittings”

b) Apollo “PowerPress”

c) Mueller Streamline STL

2.02 FITTINGS

A. Mechanically Joined Fittings: ½ inch through 4 inch meeting ANSI LC4-2012 /CSA 6.32-2012 2nd Edition with zinc/nickel coating, HNBR sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Smart Connect (SC) Feature that allows the joint to leak if not properly sealed. Fittings shall be for use with IPS schedule 10 thru schedule 40 carbon steel, or galvanized pipe meeting ASTM A53. Fittings shall have temperature and pressure rating of -40F to 180F at a maximum operating pressure of 125 psi.

2.03 VALVES

A. Mechanically Joined Gas Ball Valves: ½ inch through 2 inch carbon steel body meeting ASTM A216 or bronze body meeting ASTM B584, with full port 316 stainless steel ball meeting ASTM A276, blowout-proof stem, with replaceable "Teflon" or "PTFE" seats and seals, solder ends and vinyl-covered steel handle. Provide with mechanically joined ends meeting ASTM LC4 with HNBR O-ring.

1. Apollo “PowerPress” # 89FVH4 series

2. Viega “MegaPress G” series #6675

B. Mechanically Joined Gas Ball Valves: 2-1/2 inch through 4 inch carbon steel body meeting ASTM A216 with zinc-nickel coating, with full port chrome plated brass ball, blowout-proof stem, with replaceable "Teflon" or "PTFE" seats and seals, solder ends and vinyl-covered steel handle. Provide with mechanically joined ends meeting ASTM LC4 with HNBR O-ring.

1. Viega “MegaPress G” series #6675XL

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Install fittings and valves in accordance with manufacturer’s installation instructions.

3.02 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.03 PIPE APPLICATIONS

A. Install above floor steel pipe with mechanically joined fittings for pipe 1/2 inch and larger up to 4”.

3.04 PIPING INSTALLATION

A. Piping Installation requirements are specified in Division 22 Section “Natural Gas Systems”.

3.05 PIPE JOINT CONSTRUCTION

A. Joint materials and installation requirements are specified in Division 22 Section “Natural Gas Systems”.

B. Joints for Mechanically Joined Fittings: Comply with the manufacturer’s installation instructions and Requirements:

1. Cut pipe ends at right angle (square) to the pipe.
2. Ream pipe ends with chamfer.
3. Remove paint, lacquer, grease, oil or dirt from the pipe end with an abrasive cloth, or with the “Ridgid MegaPress” pipe end prep tool.
4. Visually examine the fitting sealing element to ensure there is no damage.

5. Utilize a “Viega MegaPress Insertion Depth Inspection Gauge” to mark the pipe wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.

6. Verify the pipe is fully inserted into the fitting prior to pressing the joint.

7. Install mechanically joined fittings using “Ridgid” MegaPress Tools.

3.06 VALVE APPLICATIONS

A. Valves are specified in Division 22 Section “Natural Gas Systems”.

B. Valves can be installed with screwed joints for 2” and smaller and flanged joints for 2-1/2” and larger. Or, valves can be provided with mechanically joined fitting adapters and the joints installed as specified herein.

3.07 VALVE INSTALLATIONS

A. Valve installation requirements are specified in Division 22 Section “Natural Gas Systems”.

3.08 FIELD QUALITY CONTROL

A. Field quality control requirements are specified in Division 22 Section “Natural Gas Systems”.

B. Installing contractor shall schedule training session with the mechanically joined fittings manufacturer at project site for all workers that will be installing or handling mechanically joined fittings. Submit certification letter along with list of certified attendees to Architect within 30-days of mobilization. Include copy of certification letter with closeout documents. Mechanically joined fittings manufacturer shall provide certification training to the contractor without cost and without additional cost to the Owner.

C. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

D. Manufacturer’s Piping Test: Provide two-step test process as follows:

1. Pressurize the system between 0.5 psi and 45 psi with air or dry nitrogen.

2. If the system does not hold pressure, walk the system and check for un-pressed fittings.

3. If un-pressed fittings are found, ensure the pipe is fully inserted into the fitting and properly marked prior to pressing the joint.

4. If failed joints are fond, cut out the failed fitting and replace with new as specified herein.

5. After appropriate repairs have been made, test the system per local code, not to exceed 200 psig.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA - Building Officials Code Administration

IBC - International Building Code

IMC - International Mechanical Code

IPC - International Plumbing Code

IECC - International Energy Conservation Code

IFC - International Fire Code

IFGC - International Fuel Gas Code

ADA - American Disabilities Act

ADC - Air Diffusion Council

AMCA - Air Movement and Control Association, Inc.

ANSI - American National Standards Institute

AHRI - Air Conditioning, Heating and Refrigeration Institute

ASHRAE - American Society of Heating Refrigerating and Air Conditioning Engineers

ASME - American Society of Mechanical Engineers

ASSE - American Society of Sanitary Engineering

ASTM - American Society of Testing Materials

AWS - American Welding Society

AWWA - American Water Works Association

CISPI - Cast Iron Soil Pipe Institute

ETL - Electrical Testing Laboratories

FGI - Facilities Guideline Institute

HI - Hydraulic Institute

MSS - Manufacturer's Standardization Society of the Valve and Fitting Industry

NBFU - National Board of Fire Underwriters

NEC - National Electrical Code

NFPA - National Fire Protection Association

NEMA - National Electrical Manufactures' Association

OSHA - Occupational Safety and Health Act

PDI - Plumbing and Drainage Institute

SMACNA - Sheet Metal and Air Conditioning Contractors National Association, Inc.

UL - Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment

in a context clearly requiring an obligation of Contractor, “provide” is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a) Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b) Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

6. Building Fill: Building fill as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations

1.05 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate the work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.06 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.07 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract

Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.08 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or a time specified in the Engineer's Agreement with the Client, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the

materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. Provide welders' qualification certificates.

N. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.

1.09 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect’s written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to

payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    a) Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b) Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c) Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d) Same warranty will be furnished for proposed substitution as for specified Work.
    e) If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f) Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in each individual Section.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports and exposed insulated piping shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all

times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.
2. Insulation shall be effective.
3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.18 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.

2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.19 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.

2. Work in the existing building shall be scheduled with the Owner.

3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.

4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become their property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.

6. General Contractor shall install finish material.

7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Bedding Material: Provide clean sand, pea gravel or flowable fill material (per the geotechnical or structural engineer's recommendations).

B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially graded crushed aggregate. Corrosive fill

materials shall be not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and shall be free of debris, waste, frozen materials, vegetable and other deleterious matter.

C. Drainage Fill: Provide washed, evenly graded mixture of 3/4" open graded aggregate stone or gravel, around drainage pipes to a level above pipe as detailed by Architect. Provide open graded aggregate, crushed stone, crushed or uncrushed gravel with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve for drainage fill to subgrade or around equipment structures.

D. Filter Fabric: Flat needle punched PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

PART 3 - EXECUTION

3.01 PERMITS

A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in their bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.03 SELECTIVE DEMOLITION

A. Refer to Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.

a) Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

b) Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.

F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.04 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation and Trenching shall be in conformance with applicable Division and section of the General Specifications.

C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

E. Erect barricades around excavations and trenches for safety. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.

F. Slope sides of excavations and trenches to comply with Geotechnical Report, local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations and trenches regardless of time period excavations and trenches will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering of Excavation and Trenches: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.

1. Do not allow water to accumulate in excavation or trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations and trenches.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas.

3. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations and trenches. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks, Basins, and Mechanical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root

system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of sand or pea gravel prior to installation of pipe. Provide a minimum of 6 inches of sand or pea gravel cushion between rock bearing surface and pipe.

5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment bedding on undisturbed soil.

M. Cold Weather Protection: Protect excavation and trench bottoms against freezing when atmospheric temperature is less than 35°F.

N. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below.

2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under pipes, use bedding materials in layers to 6 inches above top of the pipe.

2. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

3. Under building slabs, use subbase materials.

4. Under piping and equipment, use bedding and subbase materials over rock bearing surface and for correction of unauthorized excavation.

5. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete protection slab. After installation and testing of pipes, provide a 4-inch thick concrete protection top slab prior to backfilling and placement of roadway subbase. Contractor shall coordinate with local AHJ as to requirements for colored concrete in this application.

6. Other areas, use excavated or borrowed materials where applicable.

7. Backfill excavations as promptly as work permits, but not until completion of the following:

    a) Inspection, testing, approval, and locations of underground utilities have been recorded.

    b) Removal of concrete formwork.

    c) Removal of shoring and bracing, and backfilling of voids.

    d) Removal of trash and debris.

8. Where gravel fill (drainage fill) is used as building fill material in lieu of natural soils, provide filter fabric material to line the trench to support the bedding fill material and subgrade materials to ensure that backfill materials will not segregate within the trench nor create voids and sags within the pipe trench.

9. Ductwork under slab shall be backfilled with a minimum of 4" bedding material on all sides for protection from soils (per Code). Subbase materials shall be utilized above the bedding material to the subgrade level.

    a) If concrete encasement is required, a minimum of 4" thickness all sides shall be provided unless otherwise noted. Contractor shall provide hold down straps as per manufacturer's recommendations.

    b) If a concrete ballast pad is required, size of ballast pad shall be as noted on the drawings or as per manufacturer's recommendations.

P. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

Q. Subgrade Placement and Compaction: Place subgrade backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

R. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

S. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

T. Placement and Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Use of pneumatic backhoe as compaction method is disallowed as an acceptable process for compaction of excavations or trenches.
2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.
3. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.
5. Compaction: control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
6. Percentage of maximum density requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a) Areas under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for cohesive material listed, or 95 percent relative density for cohesionless material.

b) Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

c) Other Areas: Compact top 6 inches of subgrade and each layer of subbase backfill or fill material to 90 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

U. Subsidence: Where subsidence occurs at mechanical installation excavations and trenches during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.05 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.06 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.07 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections as required in each individual Section.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, the Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.02 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.03 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL” for specification of motor connections.

C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.

D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.01 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Motor control centers	DIV26	DIV26	DIV26	DIV23t
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Overload heaters	DIV23m	DIV26	---	---
Loose motor starters, disconnect switches, thermal overloads and heaters	DIV26	DIV26	DIV26	DIV23t
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Manual operating multi-speed switches	DIV23m	DIV26	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Time switches (more mechanical equipment)	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t

Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Smoke dampers and combination fire/smoke dampers	DIV23m	DIV23m	DIV26	DIV28
Smoke dampers for smoke control system	DIV23t	DIV23m	DIV26	DIV23t/28
Control dampers (MD)	DIV23t	DIV23m	DIV26	DIV23t
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Refrigeration equipment and controls	DIV23m	DIV23m	DIV26	DIV23t
Pushbutton stations and connection	DIV23m	DIV23m	DIV26	DIV23t
Temporary heating connections	DIV23m	DIV23m	DIV26	DIV23m
Interlocks between air handling units and exhaust fans	---	---	---	DIV23m
Interlocks between HVAC fans and damper operators	---	---	DIV26	DIV23t
Interlocks between kitchen exhaust	---	---	---	DIV23m

hood(s) and make-up air unit(s)				

DIV23m = Mechanical Contractor

DIV23t = Temperature Controls Sub-Contractor

DIV26 = Electrical Contractor

DIV28 = Electronic Safety and Security

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

B. Mechanical equipment nameplate data.

C. Drip pans with detection.

D. Sleeves for mechanical penetrations.

E. Joint sealers for sealing around mechanical materials and equipment.

F. Miscellaneous metals for support of mechanical materials and equipment.

G. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.

H. Plenum insulation for enclosure of combustible items located within fire-rated plenums.

I. Firestopping.

1.02 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 23 Section General Mechanical Requirements.

B. Product data for the following products:

1. Access panels and doors.
2. Joint sealers.
3. Through and membrane-penetration firestopping systems.
4. Plenum insulation.

C. Shop Drawings: Detailing fabrication and installation for metal fabrications, wood supports, and anchorage for mechanical materials and equipment.

D. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

E. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

F. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.04 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

Space	**RC Levels**
Sanctuary	25
Choir Risers	25

Stage	25
Sound/Lighting Control Rooms	25
A/V Spaces	25
TV Production Studio	25
Drama Theatre	25
Music Teaching Studios	25
Teleconference Rooms	25
Meeting/Banquet Rooms	30
Conference Rooms	30
Courtrooms	30

PART 2 - PRODUCTS

2.01 ACCESS DOORS

A. Refer to Architectural documents for specification of Access Panels and Access Doors.

2.02 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.03 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.04 DRIP PANS

A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2" lapped and soldered joints. Drip pan shall have a depth of 2" and a width of 6" in addition to the diameter of the associated pipe. Provide 3/4" galvanized pipe with male NPT outlet at low point of drip pan. Connect ¾" type "L" copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

B. Drip pan supports shall be ¼" X 2" galvanized bar stock welded to the drip pan without holes. Provide ¼" galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

C. Flood Detector: Flood detector switch utilizing hydrophilic pad and stainless steel sensor array to detect moisture. Switch shall be provided with integral feet to prevent pad from contacting the pan. Provide with solid state electronics and double throw relay to allow switch to shut down unit and provide an auxiliary alarm output.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Diversitech.

2.05 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.06 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.07 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturer:

a) Dow Corning, Dowsil 790.

b) Dow Corning, Dowsil 795.

c) GE, Silglaze II SCS 2350.

d) GE, Silpruf SCS 2000.

e) Owens Corning, Energy Complete.

f) Pecora, 864 NST.

g) Tremco, Spectrem 1.

h) Tremco, Spectrem 2.

D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

1. Manufacturers:

a) Dow Corning, Dowsil 786.

b) GE, Momentum SCS 1700.

c) Pecora, 898 Silicone NST.

E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.

1. Manufacturers:

a) BASF, MasterSeal NP 100.

b) Pecora, DyanTrol I-XL.

c) Tremco, Dymonic FC.

F. Acrylic Latex Joint Sealer: One-part, nonsag, mildew-resistant, paintable acrylic latext or siliconized acrylic latex complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:

a) Pecora, AC-20.

b) Sherwin Williams, 950A.

c) Tremco, Tremflex 834.

2.08 ACOUSTICAL SEALANTS

A. General: Penetrations by ducts, pipes and conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

E. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90. Meeting ASTM E84 for a smoke flame spread index of less than 25 / 50.

F. Manufacturers:

1. Pecora, AC-20 FTR.
2. Pecora, AIS-919.
3. USG, SHEETROCK Acoustical Sealant.

2.09 PLENUM INSULATION

A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.

B. Material: Provide light weight, high temperature, inorganic fiber blanket enhanced for biosolubility and encapsulated with a scrim-reinforced foil.

C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

D. Physical Properties: Plenum insulation shall be single, minimum 1/2" thick layer with a density of 2 to 8 pounds per cubic foot.

E. Acceptable Manufacturers and Products:

1. 3M Fire Barrier Plenum Wrap 5A+.
2. ETS Schaefer Plenumshield Blanket.
3. Knauf Earthwool 1000^{o} Pipe Insulation with ECOSE Technology.
4. Morgan Advanced Materials – Thermal Ceramics FireMaster PlenumWrap+.
5. Owens Corning Pipe Insulation SSL II with ASJ Max Jacket.
6. Unifrax FyreWrap 0.5 Plenum Insulation.

2.10 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ.

B. Manufacturers:

1. 3M Corp., Fire Barrier Sealant.
2. Hilti.
3. Owens Corning, Firestopping Insulation.
4. Pecora, AS-20 FTR.
5. RectorSeal.
6. Specified Technologies Inc., Firestop.
7. USG Sheetrock, Firecode Compound.
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

3.02 INSTALLATION OF ACCESS DOORS

A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section “Identification for HVAC Piping and Equipment” for labeling of access doors.

B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

C. Access doors must be of the proper construction for type of construction where installed.

D. The exact location of all access doors shall be verified with the Architect prior to installation.

E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

F. Adjust hardware and panels after installation for proper operation.

3.03 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.04 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.05 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.06 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.07 PENETRATIONS

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.

H. Cut sleeves to length for mounting flush with both surfaces of walls.

I. Extend sleeves installed in floors 2 inches above finished floor level.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

K. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

L. All circular and oval openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section “Basic Piping Materials and Methods”. All rectangular openings through underground exterior walls shall be flanged and flashed with non-corrosive material on each side and the gap sealed with weatherproof sealant.

3.08 DRIP PAN INSTALLATION

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans under piping or equipment that is installed in spaces that have sensitive electronics/electrical equipment such as electrical, IT/AV, telecom, data equipment, elevator machinery rooms, etc. Obtain approval from the Architect prior to installation.

C. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.

D. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

E. Provide drip pan supports every 4’-0”.

F. Place flood detector in the lowest location in the drip pan. Interlock detector with the HVAC equipment per manufacturer’s recommendations.

G. Wire flood detector to remote alarm, Diversitech Universal Alarm or equivalent. Coordinate location of the remote alarm with building owner prior to installation.

H. Coordinate interlock of “Water Present” alarm and "Cable Fault" alarm with building automation system. Refer to Division 23 Section “Direct Digital Controls for HVAC” for integration with building automation system and low voltage power wiring.

3.09 ACOUSTICAL PENETRATIONS:

A. General: There shall be no direct contact of Sheet Metal or piping with shaft walls, floor slabs and/or partitions. All openings around pipes and ducts in the structure surrounding the mechanical equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein.. This includes all slab penetrations and penetrations of noise critical walls.

B. Duct Penetrations: Where each duct passes through a wall, floor or ceiling of a noise critical space, there shall be a clear annular space of 1 inch between the duct

and structure. After all of the ductwork is installed, the Contractor shall check the clearance, pack the voids full depth with packing material and caulk both ends with non-hardening sealant backed by foam rod or permanently flexible firestop material. Where there is not sufficient access space to pack around all sides of a duct (for example, at the underside of a slab), place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

C. HVAC Piping:

1. Provide a steel sleeve cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, verify the specified clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

2. Provide factory fabricated split seal clamp around the pipe filled with closed-cell neoprene sponge insulation, thickness as required to match adjacent insulation, minimum 3/4 inch. Cast or grout the sleeve into the structure. Provide fiberglass insulation if the pipe is subject to temperatures greater than 225 degrees F. Provide Mason Industries Type SWS or approved equal.

3.10 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1” perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer’s written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated plenums where the use of plenum insulation is not approved.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Joining materials.

B. Escutcheons.

C. Mechanical sleeve seals.

D. Pipe roof curbs.

1.02 SUBMITTALS

A. Refer to Division 01 and 23 0010 - GENERAL MECHANICAL REQUIREMENTS for administrative and procedural requirements for submittals.

B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.

C. Quality Assurance Submittals: Submit welders' certificates specified in Article "Quality Assurance" below.

D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer's catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).

E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

G. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.

H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

K. As-built drawings for each piping system in electronic and PDF format.

L. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.03 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section IX, "Welding, Brazing, and Fusing Qualifications."

B. Comply with ASME B31.9 - Building Services Piping, most recent edition.

C. Comply with American Welding Society (AWS), Welding Handbook, most recent edition.

D. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.

E. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.

F. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.02 JOINING MATERIALS

A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Welding Materials: Comply with AWS D10.12 and Section II, Part C, ASME BPVC for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

D. Brazing Filler Metals: Comply with SFA-5.8, Section II, ASME BPVC for brazing filler metal materials appropriate for the materials being joined.

1. AWS A5.8, Classification BAg–5:
    a) Silver (Ag) 44.0 – 46.0 percent.
    b) Zinc (Z) 23.0 – 27.0 percent.
    c) Copper (Cu) 29.0 – 31.0 percent.
2. AWS A5.8, Classification BCuP–5:
    a) Phosphorus (P) 4.8 - 5.2 percent.
    b) Silver (Ag) 14.5 - 15.5 percent.
    c) Copper (Cu) remainder.

E. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.

F. Plastic Pipe Solvent Cement:

1. PVC: ASTM D2564.
2. CPVC: ASTM F493.

G. Gaskets for Flanged Joints: ASME B16.21, full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ASME Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.03 ESCUTCHEONS

A. Manufacturers:

1. AWI Manufacturing.

2. Keeney Manufacturing Company.

3. Wal-Rich Corp.

4. Jones Stephens Corp.

5. Approved equal.

B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.04 PIPE ROOF CURBS

A. Manufacturers:

1. AES Industries.

2. Custom Curb, Inc.

3. Pate Company.

4. Thybar.

B. Provide factory-fabricated, pipe roof curbs with the following features:

1. Factory installed treated wood nailer.

2. Welded, 18 gauge galvanized steel shell, base plate and flashing.

3. 1-1/2" thick, 3 pound rigid insulation.

4. Fully mitered 3-inch raised cant.

5. Cover of weather-resistant, weather-proof material.

6. Pipe collar of weather-resistant material with stainless steel pipe clamps.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer

to individual system specifications for requirements for coordination drawing submittals.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations. Provide deep pattern escutcheons where required to conceal protruding pipe fittings.

D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

J. Verify final equipment locations for roughing in.

K. Use fittings for all changes in direction and all branch connections.

L. Remake leaking joints using new materials.

M. Install components with pressure rating equal to or greater than system operating pressure.

N. Piping Protection:

1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.03 PENETRATIONS:

A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall

assemblies. Reference 23 0500 - COMMON WORK RESULTS FOR HVAC for additional penetration requirements.

B. Above Grade Concrete or Masonry Penetrations:

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.

a) Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b) Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c) Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d) Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

C. Above Ground, Exterior Wall Penetrations:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron sleeves, extend top of sleeve minimum 1 inch above finish floor. Size sleeve for minimum 1/2 inch annular space between pipe and sleeve.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."

5. Extend bottom of sleeve below floor slab as required and secure underdeck clamp to hold sleeve rigidly in place.

E. Interior Penetrations of Non-Fire-Rated Walls:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

F. Fire / Smoke Rated Floor and Wall Assemblies:

1. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.

G. Acoustical Barrier Penetrations:

1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The internal diameter of the sleeve shall be minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.

2. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.04 PIPE JOINT CONSTRUCTION

A. Threaded Joints:

1. Provide tapered pipe threads for field cut threads. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full inner diameter.
3. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine how far pipe should be threaded into joint.
4. Align threads at point of assembly.
5. Apply appropriate tape or thread compound to the male pipe threads except where dry seal threading is specified.
6. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Tighten joint to leave not more than 3 threads exposed.
7. Damaged Threads: Do not use pipe or pipe fittings with threads which are corroded or damaged.

B. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned.
3. Align flanges surfaces parallel.
4. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.
5. Use suitable lubricants on bolt threads.
6. Tighten bolts gradually and uniformly using torque wrench.

C. Welded Joints:

1. Comply with the requirement in ASME Code B31.9, "Building Services Piping."
2. Damaged Welds: Do not use pipe sections that have cracked or open welds.

D. Brazed and Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
3. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

4. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.

5. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.

6. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

7. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.

8. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.

9. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.

10. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.

11. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

E. Mechanical Refrigerant Pipe Joints: Flared compression fittings may be used for refrigerant lines 3/4 inche and smaller.

F. Socket Joints:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

2. Prepare surfaces to be solvent cemented by wiping with a clean cloth moistened with acetone or methylethyl keytone.

3. CPVC Joints: Solvent cement joints in accordance with ASTM D2846.

4. PVC Joints: Solvent cement joints in accordance to ASTM D2672.

G. Joints for other piping materials are specified within the respective piping system Sections.

3.05 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

F. Capacitors.

1.02 SUBMITTALS

A. Conform with the submittal procedures in Division 01.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.03 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.05 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company.

B. General Electric.

C. Gould.

D. Marathon.

E. Regal-Beloit Corporation (Century).

F. Westinghouse.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings:

1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.

B. Construction:

1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
4. Motors with frame sizes 254T and larger: Energy efficient type.

C. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be 5 feet.

2.03 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Single phase motors for pumps for oil burners: Split phase type.

C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

D. Single phase motors for fans, pumps, blowers, and air compressors: Capacitor start type.

E. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.

F. Motors located in exterior locations, air cooled condensers, humidifiers, and explosion proof environments: Totally enclosed fan cooled type.

G. Motors located in outdoors in wet airstreams, including but not limited to cooling towers, evaporative condensers, and sprayed coils: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 2913.

K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: To NEMA MG 00001.

M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.

N. Motors controlled by variable frequency drives:

1. Rated for voltage peaks and minimum rise times in accordance with NEMA MG 00001, Part 31.
2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
3. Inverter-Duty Motors: Class B temperature rise; Class F insulation.
4. Shaft Bearing Protection:
    a) Provide shaft grounding system product as listed below. Install system in accordance with manufacturer's recommendations.
        1) AEGIS SGR Bearing Protection Ring,
        2) Inpro/Seal Current Diverter Ring (CDR).
        3) Helwig Carbon Products BPK.
    b) Provide magnetic core product as listed below. Install system in accordance with manufacturer's recommendations.
        1) VLT MCC 105.
        2) CoolBLUE Inductive Absorbers.
5. Motor Overload Relay: When a single drive is used to supply power to multiple motors, provide a solid state 3-phase adjustable overload relay between the drive and each motor.
    a) Relay shall have manual reset.
    b) Provide alarm contact with automatic reset overloads.

O. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

P. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

Q. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

R. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.08 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.09 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnated.
5. Craft tissue insulation.
6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

D. Install motor overload relays in a common enclosure adjacent to the variable frequency drive

3.02 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.03 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

3.04 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85.5	65
2	1200	184T	86.5	68
3	1200	213T	87.5	63
5	1200	215T	87.5	66
7-1/2	1200	254T	89.5	68
10	1200	256T	89.5	75
15	1200	284T	90.2	72
20	1200	286T	90.2	76
25	1200	324T	91.7	71
30	1200	326T	91.7	79
40	1200	364T	93	78
50	1200	365T	93	81
60	1200	404T	93.6	83
75	1200	405T	93.6	80
100	1200	444T	94.1	83
125	1200	445T	94.1	85
1	1800	143T	82.5	84

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	89.5	85
10	1800	215T	89.5	84
15	1800	254T	91	86
20	1800	256T	91	85
25	1800	284T	92.4	84
30	1800	286T	92.4	86
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	87
75	1800	365T	94.1	87
100	1800	405T	94.5	86
125	1800	444T	94.5	87
150	1800	445T	95	88
200	1800	447T	95	87
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	182T	85.5	87
5	3600	184T	87.5	88
7-1/2	3600	213T	88.5	86
10	3600	215T	89.5	86
15	3600	254T	90.2	91
20	3600	256T	90.2	89
25	3600	284T	91	92
30	3600	286T	91	92
40	3600	324T	91.7	91
50	3600	326T	92.4	92
60	3600	364T	93	93
75	3600	365T	93	91
100	3600	405T	93.6	92

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable speed drives shall be furnished for those units so indicated on the drawings. All variable speed drives provided under this section shall be by the same manufacturer.

B. Type of variable speed drive specified in this Section include the following:

1. Pulse Width Modulated

1.02 CODES AND STANDARDS:

A. The VFD shall meet the following standards.

1. Institute of Electrical and Electronic Engineers (IEEE)
2. Nationally recognized testing lab such as UL or ETL
   a) UL 508C (Variable frequency drive)
   b) UL 508A (Bypass)
3. NEMA – ICS 7.0, AC Adjustable Speed Drives

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product Data: Submit manufacturer's technical product data for variable speed drive including dimensions, capacities, component performance data, ratings, features, motor electrical characteristics, over current protection rating, gages and finishes of material, and installation instructions.
2. Shop Drawings: Submit assembly-type shop drawings including unit dimensions, required clearances, control description, construction details, and field connection details.
3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to variable speed drives. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
4. Maintenance Data: Submit maintenance instructions, including instructions for adjustments, troubleshooting, operation, testing and spare parts lists. Include this data, product data, shop drawings, and wiring

diagrams in maintenance manuals; in accordance with requirements of Division 1 and Division 23 Section “General Mechanical Requirements.”

1.04 QUALITY ASSURANCE

A. Testing: The variable speed drive, all components and subassemblies shall be factory tested. The variable speed drive shall be tested and cycled under motor load.

B. Reliability: A complete description of supplier's Quality Assurance and Testing program shall be provided.

1. Component Testing: All power semiconductors and integrated circuits shall be 100% tested.

2. Computerized ATE Testing: Computerized Automated Testing Equipment (ATE) testing shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are cycled between 0°C and 65°C and receive electrical power-on and power-off cycle tests.

3. Burn In: All VFD's shall be tested/run in the equivalent of a NEMA 3R enclosure and burned in at rated ambient (40°C) with a fully loaded motor.

1.05 WARRANTY

A. Provide warranty including on site parts and labor for minimum 36 months from date of shipment.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide factory assembled and factory tested variable speed drives as indicated, of sizes and capabilities as scheduled, and as specified herein.

2.02 MANUFACTURERS:

A. Subject to compliance with requirements, manufacturers offering variable speed drives which may be incorporated in the work are limited to the following:

1. ABB.
2. Danfoss.
3. Delta Controls
4. Eaton/Cutler-Hammer.
5. Franklin Control Systems.
6. Invertek
7. Square D, a division of Schneider Electric.
8. Yaskawa Electric America.

2.03 VARIABLE FREQUENCY DRIVES

A. The VFD shall provide the following design features as standard:

1. Input Section: Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus. Drive shall be provided with dual DC bus chokes or AC line reactors, as required, for a total input impedance of 5 percent or better.

2. Output Section: The inverter shall use power transistors to provide three phase output power to the motor.

3. Input Displacement Power Factor: The input displacement power factor shall be 0.97 or higher at all operating speeds and loads.

4. Microprocessor Logic: The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. Use of potentiometers for parameter adjustment is not acceptable.

5. Auto Restart: The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to 5). If the drive reaches the limit of restarts without successfully restarting and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.

6. Current Limit: A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 110 percent.

7. Digital Output Displays and Input Parameter Programming: The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency, and percent of base speed, motor amps, output motor volts, and output load. The display shall also function as a first fault indicator.

8. Critical Frequency Avoidance (Frequency Jump Points): The VFD shall provide selectable frequency jump points to be used to avoid critical resonance frequencies of the mechanical system.

9. Input Signal Follower: The input signal follower circuit shall have selectable differential inputs and accept an electrical speed command from an external source rated at 4-20 mA or 0-10Vdc. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands.

10. Motor Overload Protection: Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputting specific parameters including motor design type (TEFC, ODP, or other) and speed range. The protection shall provide an orderly shutdown should the motor's thermal capabilities be exceeded. This protection also

eliminates the requirement for motor overload relays on single motor applications when a bypass is not used.

11. Open Collector Outputs: The VFD shall include three (3) open collector outputs to indicate drive run, drive fault, and drive ready.

12. Output Signals: The VFD shall include analog output signals for output load, output speed, instantaneous kw and motor voltage. The signals shall be 4-20 ma or 0-10 Vdc at 1 mA.

13. Stop Mode Functions: The VFD stopping mode functions shall be selectable for coast-to-rest or stopping at programmed deceleration rate.

14. V/Hz Profiles: The VFD shall provide selectable V/Hz profiles.

15. Loss of Control Signal: The VFD shall revert to the last speed on loss of input control signal. Owner shall be able to field select a preset speed for the VFD to run when control signal is lost, if preferred. In either case, an open collector output shall be selected to indicate loss of control signal for remote indication purposes.

B. The VFD supplier shall provide the same design/technology to cover the HP range for all VFD's.

C. Output Ratings: The VFD shall operate within the following ratings:

1. Frequency range: 1-120 Hz

2. Overload rating: 110 percent for one minute

D. Motor Performance: The VFD shall provide 3 percent speed regulation.

E. Input Power: The VFD shall operate within (plust 5 percent / minus10 percent) of the nominal rated voltage.

F. Set-up Adjustments: Standard setup adjustments shall include:

1. Minimum speed: 0 to 100 percent.

2. Maximum speed: 0 to 100 percent.

3. Linear accel: 0.5 to 600 seconds.

4. Linear decel: 0.5 to 600 seconds.

5. Maximum output voltage: Adjustable.

6. V/Hz: Adjustable with selectable profiles.

7. Current limit: 50 to 110 percent.

G. Environmental Ratings: The VFD shall operate within the following parameters without the requirement for derating:

1. Operating temperature: 0 to 40 degreees C.

2. Altitude: Up to 1000m (3300 ft).

3. Humidity: 95 percent non-condensing.

H. Enclosure: Refer to VFD schedule or drawings for enclosure type. At minimum, the enclosure shall be suitable for environment installed. Finned heatsinks and/or cooling fans shall be provided as necessary for proper heat dissipation.

I. Protective Features: The VFD shall be designed to meet the following specifications and operate within the following parameters:

1. AC Input Overcurrent Protection: The VFD's power circuit shall be isolated internally with respect to ground and provided with a 100,000 AIC interrupting rated input circuit breaker. As an alternate to the circuit breaker, fuses may be used to accomplish the 100,000 A interrupting rating.
2. Logic Common: The power unit's logic common shall be at ground potential.
3. Phase Loss Protection: Phase loss protection shall be provided to prevent single phasing.
4. Power Loss Ride-Through: The VFD shall be capable of continued operation during an intermittent loss of power. Opening of the VFD's input and/or output line switches while operating shall not result in damage to the power circuit components.
5. Short Circuit and Ground Fault Protection: The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at nominal rated voltage plus 10 percent (i.e., 480V rated drive + 10% = 528V short circuit voltage). The VFD shall be capable of providing 110% motor current intermittently. The VFD shall include an instantaneous overcurrent trip and shall not restart after electronic overcurrent trip until reset through the run/stop circuit, or unless the auto restart function has been enabled.
6. Transient and Surge Voltage Protection: Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOVs). The VFD shall withstand a 6000 volt, 80 joule surge voltage when tested in accordance with UL 1449 with the test circuit adjusted for a 2100 amp peak 8x20 us short circuit discharge current pulse.
7. Rotating Motor Start: The VFD shall be able to start into a motor rotating in either direction and at any speed, and accelerate to set speed without any time delay, tripping or component loss.
8. DV/DT Filters: Dv/dt filters shall be provided per the VFD schedule, or if recommended by the VFD manufacturer to ensure that the VFD is applied correctly and to maintain the manufacturer’s full warranty.

J. Maintainability

1. All control circuit voltages (12VAC, 24VDC, 160VDC and 120VAC) shall be physically and electrically isolated from power circuit voltages (200 to 600VAC, 600VDC) to ensure safety to maintenance personnel.

2. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following: bus overvoltage, bus undervoltage, overcurrent, overtemperature, ground fault, and timed overload.

3. VFD shall be capable of starting and operating without a motor connected for ease of service.

4. All setup and operating parameters shall be stored in nonvolatile memory. The static memory module shall be to be removed and installed in replacement logic boards with all setup and operating parameters intact requiring no adjustment of replacement boards.

K. Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the building management system to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The building management system shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus - keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The building management system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

3. The VFD shall allow the building management system to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a

damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the building management system.

4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

L. Required Optional Features

1. Operator Panel: A door-mounted Softouch Operator Panel shall be included with the following features:

a) Shall digitally display motor speed, load, amps, and output volts. (and controller setpoint and system pressure when setpoint controller is included).

b) Shall have indication for drive run, drive ready, drive fault, plus operator function/status indication such as auto speed reference, and auto restart.

c) Shall provide selection for Hand/Off/Auto control. In Hand mode, the VFD shall be started and stopped from the operator's panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.

d) Shall provide selection for Manual/Auto Speed Reference. In the Manual Reference mode, the VFD speed reference shall be set from the operator's panel. In the Auto Reference mode, the VFD speed reference shall be set by the external source instrument signal. Selecting between Manual and Auto speed reference shall have no bearing on the Hand/Off/Auto start/stop selector, or vice versa.

e) Shall name all parameters in English, not codes or numbers.

f) Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.

g) Shall store from three to six drive faults in a history batch file in the order they occur to simplify trouble-shooting. This file will automatically be updated should new faults occur.

2. Input Overcurrent Protection Device: The operating mechanism shall be designed so that the door can be padlocked in the "OFF" position.

3. Elapsed Time Meter: Meter shall provide indication of how long the drive has been running.

4. Firestat/Freezestat: VFDs for air system fans requiring shutoff from safety devices per sequences of operation shall provide terminals for connecting normally closed remote safety devices. This emergency shutdown shall operate in any mode of operation.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which variable speed drive is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.02 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instruction.

B. Maintain minimum clearance of 12 inches on each side and 36 inches in front of the variable speed drive.

C. Install variable speed drive in the vertical position.

D. Provide separate conduits for input and output power cables.

E. Provide separate conduits for control cables and the output cables to the motor.

F. Install power and control cabling in separate conduits.

G. Provide dedicated conduits for power cables to the motors.

H. Load Side Disconnects: Provide a disconnect switch on the load side of the VFD near the motor for ease of service and safety. Disconnect switch shall be lockable in the open position when the VFD is not within sight of the motor. Operating the switch with the VFD running shall not cause any component failure. In dual motor applications, VFD shall be able to operate either motor with the other motor disconnected without requiring jumpers, parameter modifications, or other adjustments. As part of start-up, VFD supplier shall certify all load side disconnects can be opened or closed with drive running at full speed without damage to the drive.

1. When a separate disconnect is provided at the motor, provide auxiliary contact in the disconnect switch that will shut down the variable speed drive when the disconnect switch is turned off.

3.03 START UP

A. All units shall be started up at the jobsite by a factory trained and authorized representative.

3.04 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum time as specified below on the operation and maintenance of the equipment provided under this section.

1. Four hours.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter written by the Contractor stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided. Copies of the startup report shall be attached to the certification letter.

D. Schedule: Schedule training with Owner with at least 14 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal piping hangers and supports.

C. Saddles and shields.

D. Vertical piping supports.

E. Pipe alignment guides.

F. Pipe anchors.

G. Pre-engineered roof pipe supports.

H. Pre-engineered roof equipment supports.

I. Anchors and fasteners.

J. Miscellaneous materials.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

D. Maintenance Data: For inclusion in the Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.06 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test fluid. Include the weight of the pipe, valves, insulation and piping accessories.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.02 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.
2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

   a) Indoor Dry Locations: Provide painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

   b) Indoor Damp or Wet Locations: Galvanized steel or Type 304 stainless steel.

   c) Outdoor Locations: Galvanized steel or Type 304 stainless steel.

   d) Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.

   e) Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

   f) Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

   g) Stainless Steel: Type 304 or 316 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Trapeze Hangers:

1. Manufacturers:

   a) Cooper B-Line.

   b) Ferguson Enterprises/FNW.

   c) PHD Manufacturing.

   d) Thomas & Betts Corporation.

   e) Unistrut, a brand of Atkore International Inc.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-58, Type 59, MSS SP-89, and MFMA-4.

4. Channel Material:

   a) Indoor Dry Locations: Provide carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

   b) Indoor Damp or Wet Locations: Galvanized steel or Type 304 stainless steel.

   c) Outdoor Locations: Use galvanized steel or Type 304 stainless steel.

   d) All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Material:

a) Indoor Dry Locations: Zinc-plated steel.

b) Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or Type 304 stainless steel.

2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.

4. Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12 inches. Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

D. Wire Rope Pipe Hanging Systems:

1. Manufacturers:

a) ASC Engineered Solutions.

b) Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.

4. Cable Stud: Carbon steel, zinc-coated, designed for attachment to concrete inserts. Model: ASC Engineered Solutions C120.

5. Cable Coupling: Carbon steel, zinc-coated, designed for attachment to threaded rods. Model: ASC Engineered Solutions C130.

6. Cable Eyelet: Carbon steel, zinc-coated, designed to be directly attached to structural supports via anchors or fasteners. Model: ASC Engineered Solutions C150.

7. Cable Toggle: Carbon steel, zinc-coated, with toggle designed for insertion into 1/2 inch hole through steel deck hat channel and provides anchor when pulled in tension. Model: ASC Engineered Solutions C160.

8. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.

9. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.

10. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Elite Components.
4. ERICO/Michigan Hanger Co.
5. Ferguson/FNW.
6. Halfen-DEHA.
7. Hilti.
8. National Pipe Hanger Corporation.
9. PHD Manufacturing.
10. Piping Technology and Products, Inc
11. Power-Strut.
12. Unistrut.

B. Single Hangers:

1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
2. Split Ring: Carbon steel, adjustable swivel, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.
4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:

a) ASC Engineered Solutions.

b) Holdrite.

c) Klo-Shure.

2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with hangers of this type.

E. Spring Hangers:

1. Reference Section "Vibration Isolation for HVAC" for spring isolation hangers.

F. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

G. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

H. Pre-Insulated Pipe Supports:

1. Manufacturers:

a) Aeroflex USA, Inc.

b) Armacell.

c) ASC Engineered Solutions

d) Buckaroos, Inc.

e) Cooper B-Line, Inc.

f) Pipe Shields, Inc.

2. General Construction and Requirements:

a) Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.

b) Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

c) Waterproof calcium silicate insulation shall conform to ASTM C795.

d) Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.

e) Insulation inserts shall be surrounded by a 360 degree jacket or shield.

3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.04 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Manufacturers: Same as hangers and supports.

2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.

B. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.

2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

3. Lengths for pipe greater than 2 inches: Minimum 8 inch long section at each support.

4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS	**Insulation Thickness (in)**	**Minimum Shield Length (in)**					
		5	**6**	**7**	**8**	**9**	**10**
		Hanger Spacing (ft)					
<= 1	0.5	5	6	8	--	--	--
	1	3	5	5	--	--	--

	1.5	3	5	5	--	--	--
	2	3	3	3	--	--	--
	3	3	3	3	--	--	--
<=2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

C. 360 Degree Insulation Protection Shield:

1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Plastic Saddles and Shields:

1. Manufacturers:
   a) Armacell.
   b) Eaton.
   c) Hydra-Zorb.
   d) PHD Manufacturing
   e) Zsi Foster.
2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.05 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Halfen-DEHA.
4. Hilti.
5. ERICO/Michigan Hanger Co.
6. National Pipe Hanger Corporation.
7. PHD Manufacturing.
8. Piping Technology and Products, Inc.
9. Power-Strut.
10. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.

2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:

a) Hydra-Zorb; Titan Riser Clamp.

b) National Pipe Hanger.

c) Pipe Hangers, Inc.

2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.06 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper pipe. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.

2. Pipe Diameter 10 inches and Larger: Roller type.

3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.07 PIPE ANCHORS

A. Pre-Insulated Anchors: Galvanized steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.

B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.08 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Manufacturers:

1. Airtec.
2. ASC Engineered Solutions.
3. Cooper B-Line.
4. Elite Components.
5. Erico/Michigan Hanger Co/Caddy.
6. Ferguson Enterprises Inc/FNW.
7. Miro.
8. PHD Manufacturing.
9. PHP Systems/Design.
10. Roof Top Blox.
11. Unistrut, a brand of Atkore International Inc.
12. Zsi Foster.

B. General: Pre-engineered devices with embedded pipe support fixtures as specified.

C. Pedestal: Steel pedestals with thermoplastic or rubber base with the following dimensions:

1. Up to 12 inch strut length support: 18 inch x 18 inch.
2. Up to 16 inch strut length support: 24 inch x 18 inch.
3. Up to 24 inch strut length support: 30 inch x 18 inch.
4. Thickness: Minimum 3/16 inch thick.

D. Block Base: Closed-cell polyethylene blocks with the following dimensions:

1. Length: Nominal 10 inch, 12 inch, 16 inch, or 24 inch.
2. Width: Nominal 4 inches.

E. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

F. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

2.09 PRE-ENGINEERED ROOF EQUIPMENT SUPPORTS

A. Reference 23 0550 - VIBRATION ISOLATION FOR HVAC for vibration isolated pre-engineered roof equipment supports.

B. Manufacturers: Subject to compliance with requirements, provide roof equipment supports from the equipment manufacturer or from one of the following:

1. AES Industries.
2. Custom Curb, Inc.
3. Pate Company.
4. Thybar.

C. Single Rail Equipment Supports:

1. Construction:

a) Base plate with fully mitered raised cant and step to match roof insulation thickness.

b) Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.

c) Factory installed treated wood nailer.

d) 4 inch, minimum 18 gauge nailer jacket with counterflashing where equipment will not fully cover the equipment support.

D. Roof Curbs:

1. Construction:

a) Comply with NRCA standards.

b) Base plate with fully mitered raised cant and step to match roof insulation thickness.

c) Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.

d) Minimum 1-1/2 inch thick, 3 pound density rigid insulation internal to shell to maintain continuous roof insulation.

e) Factory installed treated wood nailer and drain nipple.

f) Sloped to match roof structure to enable level installation.

2.10 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:
    a) Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
    b) Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.
2. Channel Material: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.
5. Manufacturers:
    a) Same as manufacturer of metal channel (strut) framing system.
    b) DeWalt "Bang-It" concrete inserts.

D. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Vibration Isolation Anchors: Reference Section “Vibration Isolation for HVAC” for vibration isolation anchors.

2.11 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

I. Provide vibration isolators at hangers and supports where specified in Section “Vibration Isolation for HVAC".

3.03 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Diision 23 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Section "HVAC Insulation" for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
2. Where strut systems are attached to walls, install anchor bolts per manufacturer’s recommendations.

a) Uninsulated Copper Pipe: Install with plastic galvanic isolators.

b) Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Section “HVAC Insulation”.

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section “HVAC Insulation”.

a) Contractor’s Option: Provide riser clamps with pre-manufactured polymer insert.

2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

a) If insulation protection shields are used instead of protection saddles on hot piping where vapor barrier is not required, provide high density insulation insert sized for the insulation thickness used as specified in Division 23 Section “HVAC Insulation".

3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert, sized for the insulation thickness used as specified in Division 23 Section “HVAC Insulation”. Do not use polymer-based shields for hot piping.

    a) Exception for 2 inch and smaller horizontal piping with cellular glass, flexible elastomeric, or polyisocyanurate insulation: High density insulation insert is not required. Provide insulation protection shield over the insulation with length specified for pipe size and insulation thickness to prevent puncture or other damage.

4. Contractor’s Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

5. Contractor’s Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer’s recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer’s recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators.

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section “HVAC Insulation”.

P. Vertical Piping Risers:

1. Reference Section “Vibration Isolation for HVAC” for piping riser supports.

Q. Wire Rope Hanging Systems:

1. Install in accordance with manufacturer’s instructions.

2. Supported load shall not exceed manufacturer’s recommended load rating.

3. Applications for Pipe Supports:

    a) 3 inch and smaller.

    b) Wire rope hanging system is not allowed for steam or steam condensate piping.

4. Do not support pipe by wrapping the rope around the pipe.

5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in the Pipe Hanger and Support Schedule.

6. Install cast-in-place concrete inserts in elevated concrete slabs.

7. Install bream clamps for attachment to structural beams as required.

3.04 INSTALLATION OF PIPE ALIGNMENT GUIDES

A. Install pipe alignment guides at the following locations:

1. On piping that adjoins expansion joints, as required by expansion joint manufacturer. Install guide to accommodate 1/2 the thermal movement at the adjacent expansion joint.

2. Where roller hangers are required per Pipe Hanger and Support Schedule.

3. Elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems.

B. Install guides per ASME B31.9 unless noted otherwise.

C. Install pipe insulation at guide to not interfere with movement of pipe within the guide.

D. Anchor to building substrate.

3.05 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.06 INSTALLATION OF PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Install pre-engineered roof pipe supports to rest on the roofing membrane without attachment to the roof structure or penetration through the roofing assembly.

3.07 INSTALLATION OF ROOF EQUIPMENT SUPPORTS

A. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.

B. Provide multiple single rail equipments supports to uniformly support the equipment.

C. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope.

D. Provide vibration isolators between roof equipment support and equipment according to Section 23 0550 - VIBRATION ISOLATION FOR HVAC.

E. If vibration isolation is not required or units are internally isolated, attach equipment directly to pre-engineered roof equipment support using one of the following:

1. Single Rail Equipment Supports: Secure each equipment support leg to the rail with a minimum of 4 points of connection per leg.

2. Roof Curbs:

a) Secure each corner of the equipment to the curb nailer using a minimum of 4 lag screws, located along the length of the equipment.

b) Secure equipment to the curb using hold-down brackets. Provide minimum 6 inch long, 14 gauge galvanized steel brackets sized to wrap around top of curb and under equipment base rail with sufficient horizontal offset to cover overlap gap between the equipment rail and curb. Secure bracket to equipment and curb nailer using a minimum of 8 points of connection per bracket. Provide one bracket at each corner along the length of the unit.

3.08 EQUIPMENT SUPPORT AND ATTACHMENT

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

F. Secure fasteners according to manufacturer's recommended torque settings.

G. Remove temporary supports.

H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.

I. Grouting: Place grout under supports for piping and equipment.

3.09 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.10 FIELD QUALITY CONTROL

A. Examine support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.11 PIPE HANGER AND SUPPORT SCHEDULE

A. Additional hanger and support requirements are in Sections specifying piping systems and equipment.

B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

C. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:

a) Band hanger.

b) Swivel split ring.

c) Clevis hanger.

2. Cold and Hot pipe sizes 2 inches and greater where pipes are in stationary position: Clevis hanger.

3. Cold and Hot pipe sizes 2 inches and greater for pipes in the following locations: Roll support hanger.

a) Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.

b) Between anchor locations shown on the drawings.

D. Trapezes and Strut-mounted Supports:

1. Pipes in stationary position: Two-piece clamp, strut clamp or U-bolts.

2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.

a) Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.

b) Between anchor locations shown on the drawings.

E. Wall Supports:

1. Pipe sizes 3 inches and less:

a) Two-hole strap mounted to wall.

b) Welded steel bracket with reinforced angle or strut.

2. Pipe sizes 4 inch and greater:

a) U-Bolt.

b) Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipes in stationary position: Pipe saddle.

2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.

   a) Axial movement due to thermal expansion or contraction is greater than one inch.

   b) Between anchor locations shown on the drawings

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Vibration isolation requirements.

B. Vibration-isolated equipment support bases.

C. Vibration isolators.

1.02 COORDINATION

A. Contractor's Responsibility:

1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.
4. Coordinate the work with other trades to provide additional framing and materials required for installation.
5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
6. Sequencing:
    a) Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

B. Manufacturer's Responsibility:

1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.
2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.

3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.

4. Guarantee specified isolation system deflection.

5. Select and size vibration isolators to not exceed the recommended loading of the isolators.

6. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.

7. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.

B. Shop Drawings:

1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.

2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable. Indicate equipment mounting provisions.

3. Piping isolators shown and identified on piping layout drawings.

4. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:

a) Concrete reinforcing steel details and templates for all foundations and supports.

b) Required hanger bolts.

c) All other appurtenances necessary for proper installation of equipment.

C. Vibration Isolation System Schedule: Include the following for each isolation element:

1. Manufacturer, isolator type, model number, size.

2. Height when uncompressed and static deflection.

3. Spring constant.

4. Spring outside diameter, free operating, and solid heights.
5. Design of supplementary bases.
6. Details of attachment to load-bearing structure or supplementary framing.

D. Post-Installation Inspection Report:

1. Vibration isolation vendor notice of inspection of all vibration isolators.
2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.
3. Itemized list of deficiencies.
4. Vibration Isolation System Schedule.
5. For each isolator containing steel springs, record the following:
   a) Size.
   b) Uncompressed height.
   c) Design static deflection.
   d) Measured static deflection.

1.04 QUALITY ASSURANCE

A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.

C. Maintain at the project site a copy of each reference document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. BRD Noise and Vibration Control.

B. Caldyn, California Dynamics Corp.

C. Kinetics Noise Control.

D. Mason Industries, Inc.

E. Thybar Corporation.

F. Vibration Eliminator Co., Inc.

G. Vibration Mounting and Controls.

H. Vibro-Acoustics.

2.02 VIBRATION ISOLATION REQUIREMENTS

A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.

B. Select vibration isolators to provide the static deflection as specified in Part 2 "Products" unless otherwise specified for the application listed in Part 3 "Execution."

C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.

D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.

E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.

F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.

I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.

J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.

K. Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.

L. Vibration Isolator Assemblies with Steel Springs:

1. Housed or caged spring isolators are not acceptable.
2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.
4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.
5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.
7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection .

M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.

1. Exterior applications:
   a) Springs: Cadmium-plated and neoprene coated.
   b) Nuts and bolts: Cadmium plated.
   c) Other metal mounting parts: Hot-dip galvanized.
2. Interior applications: Painted.

2.03 VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. Pre-Engineered Roof Equipment Support (Type RES):

1. Reference 23 0529 - Hangers and Supports for HVAC Piping and Equipment for specification of non-vibration isolatored, pre-engineered roof equipment supports.

B. Vibration Isolated Roof Curb (Type CMB):

1. Description: Engineered, structural steel frame mounted directly to the structure with an upper floating section on adjustable steel springs. The upper frame shall provide continuous support for the equipment.
2. Steel springs shall rest on minimum 1/4 inch thick elastomeric pads and have a minimum static deflection as specified in Part 3.
3. All-directional elastomeric snubber bushings shall be minimum 1/4 inch thick.

4. Weatherproofing: Continuous galvanized flexible counterflashing nailed over the lower curb's waterproofing and joined at the corners by elastomeric bellows.

5. Access Ports: Provided for all spring locations with removable waterproof covers to allow for adjustment or replacement of springs.

6. Lower curbs shall have provision for 2" insulation.

7. Type CMB: Mason Industries Type RSC, or approved equal.

2.04 VIBRATION ISOLATORS

A. Ribbed Neoprene "Waffle" Pads (Type WP):

1. Assembly: Single ribbed or crossed double ribbed elastomer in-shear pads, in one or more layers separated and bonded to a minimum 1/4 inch thick galvanized steel shim plate as required to provide selected deflection.

2. Thickness: Each layer 5/16 inch thick.

3. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.05 inches.

4. Type WP: Mason Industries Type W, Type WSW, or approved equal.

B. Neoprene and Cotton Duck Pads (Type DP):

1. Assembly: Neoprene and cotton duck construction, 12 Plys per 1/2 inch thickness.

2. Selection: Thickness or multiple pads in series as required to limit maximum loading to 500 psi and static deflection of 0.1 inches.

3. Type DP: Mason Industries Type HL, or approved equal.

C. Restrained Neoprene Mounts (Type RNM)

1. Assembly: Restrained neoprene mounting element encapsulated in a metal housing to prevent bulging of the neoprene element with bolt holes for attachment to supporting structure. Assembly shall be designed to provide isolation in tension, shear or compression.

2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.25 inches.

3. Type RNM: Mason Industries Type RBA or approved equal.

D. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.

E. Flexible Connectors:

1. Pipe: Refer to Section "Hydronic Piping Specialties."

2. Duct: Refer to Section "Air Duct Accessories."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.02 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Support piping, ductwork, conduit, and mechanical equipment from the building structure. Do not support from other equipment, piping, or ductwork.

E. Install isolators to prevent short-circuiting of the isolation.

F. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a "U" shaped loop. Coordinate with Division 26.

G. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.

H. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

I. Refer to Section 23 0500 - COMMON WORK RESULTS FOR HVAC for noise critical spaces.

3.03 INSTALLATION OF VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. Maintain minimum 4 inches clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.

B. Adjust equipment to be level.

C. Verify no material is left to short-circuit the isolator.

D. Type CMB:

1. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.

2. Provide flexible duct connector using a foam rubber gasket to seal against the unit bottom.

3. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope on roof equipment support bases.

4. Install roof equipment support bases to maintain continuous insulation on roof.

3.04 INSTALLATION OF VIBRATION ISOLATORS

3.05 EQUIPMENT ISOLATION

A. General: External spring isolators are not required if unit is provided with internal spring isolation unless specified otherwise on the drawings. If external spring isolators are provided, internal spring isolation shall be locked in place.

B. Packaged Rooftop Units:

1. Roof-mounted, up to 20 ft span: Type CMB with 0.75 inch static deflection.

2. Roof-mounted, span of 20 ft or more: Type CMB with 2 inch static deflection.

C. Air-Cooled Condensers and Condensing Units:

1. Roof-mounted:

a) 15 ton capacity and smaller: Type WP isolation continuous along support.

b) Larger than 15 tons and all VRF Condensing Units:

1) Units Without Internal Isolation: Type RES base, Type CSNM isolation with 2 inch static deflection.

2) Units With internal isolation: Type RES base, Type WP isolation with 0.25 inch static deflection.

D. Water Source Heat Pumps, Fan Coil Units, and Computer Room Units:

1. Suspended: Flexible duct connectors with Type SPNH with 1 inch static deflection.

E. VAV Terminal Units:

1. All other Types: Flexible duct connectors.

F. Fans

1. Floor-mounted:

2. Suspended:

a) Fans 1 hp and less: Type NR isolation with 0.15 inch static deflection.

b) Fans greater than 1 hp: Type SPNH isolation with 2 inch static deflection.

3. Roof-mounted:

a) Curb mounting: Type RES curb base, with closed cell sponge gasket for sealing, continuous along support sealed to curb top rail.

b) Rail mounting:

1) Fans 10 hp and less: Type RES rail base, Type DDNM with 0.75 inch static deflection.

2) Fans greater than 10 hp: Type RES rail base, Type SPNM with 2 inch static deflection.

3.06 PIPING ISOLATION

A. Provide isolation supports on the following HVAC pipe:

1. Piping within 20 feet of the following suspended equipment: Provide Type SPNH isolators. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 0.75 inch.

a) Pipes connected without flexible connectors to suspended equipment that is installed with spring vibration isolators.

b) Pipes connected without flexible connectors to suspended in-line pumps.

2. Piping installed below or adjacent to noise sensitive areas:

a) Refer to Section “Common Work Results for HVAC” for definition of noise sensitive areas.

B. Provide resilient diagonal mountings or other approved devices as required to limit piping motion due to equipment startup or shut down to a maximum of 1/8 inch.

C. Where supplementary steel is required to support pipes, size the supplementary steel so that maximum deflection between supports does not exceed 0.08 inches. Isolate the supplementary steel from building structure using the same isolator required for the pipe. Rigidly suspend or support the pipe from the supplementary steel.

D. Provide pre-compressed hanger rod isolators for all pipes greater than 12 inch diameter and all supplementary steel supports used for the large pipe. Factory set the pre-compression at 75 percent of rated deflection.

E. Where isolated pipe 8 inch and larger is supported from exposed steel beams, use welded channel beam attachments located directly under the web of the

beam. For piping 6 inch and smaller, beam clamps may be used in lieu of welding, subject to approval of beam clamp selection.

3.07 DUCT ISOLATION

A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

B. Support grease exhaust ducts with Type SPNH and/or SPNM isolators as appropriate. Install neoprene riser guides if lateral restraint is required in shafts.

3.08 FIELD QUALITY CONTROL

A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive-backed duct markers.

D. Stencils.

E. Pipe markers.

F. Engraved plastic-laminate signs.

1.02 SUBMITTALS

A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Product Data: Submit manufacturer's technical product data for each product required.

C. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

1.03 SPARE PARTS

A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.

B. Furnish not less than 3 additional numbered valve tags for each piping system.

C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Advanced Graphic Engraving, LLC.

B. Brady Corporation.

C. Brimar Industries, Inc.

D. Craftmark.

E. Industrial Safety Supply Co., Inc.

F. Kolbi Pipe Marker Co.

G. MIFAB, Inc.

H. Seton Identification Products, a Tricor Direct Company..

2.02 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

A. General:

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.

2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).

B. Air Handling Units: Nameplates, Stencils, or Engraved plastic laminate signs .

C. Air Terminal Units: Tags, Stencils, or Engraved plastic laminate signs.

D. Control Panels: Nameplates.

E. Ductwork: Adhesive-backed duct markers. Stencils are only acceptable for concealed ductwork, exterior ductwork, or in mechanical rooms.

F. Fans: Nameplates, Stencils, or Engraved plastic laminate signs.

G. Instrumentation: Tags.

H. General Signs: Engraved plastic laminate signs.

2.03 NAMEPLATES

A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and mark number.
2. Equipment service.
3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.

C. Letter Color: White.

D. Letter Height: 1/4 inch.

E. Background Color:
1. Cooling equipment: Green.
2. Heating equipment: Yellow.
3. Combination cooling and heating equipment: Yellow/Green.
4. Hazardous equipment: Colors and designs recommended by ASME.
5. Equipment and components that do not meet any of the above criteria: Blue.

F. Plastic: Conform with ASTM D709.

2.04 TAGS

A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

C. Metal Tags: Provide 19-gauge polished Brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with balck enamel paint.

D. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).

E. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, manufactured specifically for that purpose.

F. Letter Height:

1. System Abbreviation: Minimum 1/4 inch.

2. Valve Number: Minimum 1/2 inch.

2.05 ADHESIVE-BACKED DUCT MARKERS

A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual Label.

C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.

D. Specialty Exhaust: Identify the specialty using the system terminology (e.g., Grease, Dishwasher, Dryer, Fume Hood, etc.).

E. Color: Yellow background with black lettering or blue background with white lettering.

1. Hazardous Exhaust: Use colors and designs recommended by ASME A13.1.

2.06 STENCILS

A. Stencils: With clean cut symbols and letters of following size, complying with ASME A13.1:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.

2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.

3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.

5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.

6. Ductwork and Equipment: 2-1/2 inch high letters.

7. Access Doors: 3/4 inch high letters.

8. Operational Instructions: 3/4 inch high letters.

9. Provide arrows indicating direction of flow.

B. Stencil Paint: Oil based, alkyd enamel, either brushing grade or pressurized spray-can form and grade, black color, except for piping. For piping systems use colors conforming to ASME A13.1.

2.07 PIPE MARKERS

A. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).

C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.

D. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.

E. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.

F. Color:

1. Conform to ASME A13.1.
2. Heating, Cooling, and Boiler Feedwater: Green with white letters.
3. Toxic and Corrosive Fluids: Orange with black letters.
4. Compressed Air: Blue with white letters.

G. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.08 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, engraved with manufacturer’s standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:

1. Name and mark number.
2. Equipment service.
3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.02 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Install products in accordance with manufacturer's instructions.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Install tags with corrosion resistant chain.

E. Install in clear view and align with axis of piping.

F. Apply stencil painting in accordance with Division 09.

G. Identify service, flow direction, and pressure.

3.03 PIPING IDENTIFICATION

A. General: Install identification on the most obviously visible portion of the pipe from the point of access.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

C. Pipes less than 6 inches diameter (including insulation): Provide full-band pipe markers with 360 degree coverage.

D. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers.

E. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:

1. Within 5 feet of each valve, tee, and control device.
2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.
3. Within 5 feet of each side of a wall, floor, ceiling, structure, or enclosure.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of equipment outlets and other points of origination and termination.
6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

F. Identify refrigerant piping located in areas other than the room or space where the refrigerant equipment is located in accordance with ANSI/ASME A13.1.

1. Indicate the refrigerant designation and safety group classification of refrigerant used in the piping system.
2. For Group A2L refrigerant piping include the following statement: “WARNING – Risk of Fire, Flammable Refrigerant”.

3.04 DUCTWORK IDENTIFICATION

A. Install identification on the most obviously visible portion of the duct from the point of access.

B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:

1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.

3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.

5. Within 5 feet of equipment outlets and other points of origin or termination.

6. Install marker on the most obviously visible portion of the duct from point of access.

3.05 ACCESS DOOR IDENTIFICATION

A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.

B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.06 EQUIPMENT IDENTIFICATION

A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:

1. To distinguish between multiple units in close proximity.

2. To inform operator of operational requirements.

3. To indicate safety and emergency precautions.

4. To warn of hazards and improper operations.

B. Adjust lettering size based on viewing distance from normal location of identification:

1. Less than 2 feet: Minimum 1/4 inch.

2. Up to 6 feet: Minimum 1/2 inch.

3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.

4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.

C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General testing, adjustment, and balancing requirements.

B. Testing, adjustment, and balancing of air systems.

C. Sound and vibration measurement of equipment operating conditions.

D. This section excludes:

1. Testing boilers and pressure vessels for compliance with safety codes.
2. Specifications of materials for patching mechanical systems.
3. Specifications of materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, reference the respective system specification section for materials and installation requirements.
4. Requirements and procedures for piping and ductwork system leakage tests.

1.02 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling, etc.).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals).

E. Procedure: Standardized approach and sequence of work operations to yield reproducible results.

F. Report Forms: Data sheets arranged for collecting test data in logical order for submission and review. Data also forms the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves a distribution system. Examples include inlet and outlets on water terminals, outlets from supply diffusers, and inlets to return or exhaust grilles.

H. Main: Duct or pipe containing the system’s major or entire fluid flow.

I. Submain: Duct or pipe containing part of the system's capacity and serving two or more branch mains.

J. Branch main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.03 SUBMITTALS

A. Qualifications:

1. Submit qualifications of the TAB agency.

2. Submit qualifications of the TAB supervisor.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

E. Progress Reports.

F. Certified TAB Reports:

1. General:

a) Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

b) Submit within two weeks after completion of testing, adjusting, and balancing.

c) Revise TAB plan to reflect actual procedures and submit as part of final report.

2. Draft Reports: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:

a) The systems have been tested, adjusted, and balanced in accordance with the referenced standards.

b) The report reflects an accurate representation of how the systems have been installed.

c) The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.

d) The report is an accurate record of all final quantities measured to establish normal operating values of the systems.

4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:

a) General Information and Summary

1) Include project name, location, altitude, and date.

2) Identify TAB agency, contractor, owner, architect, and engineer.

3) Include addresses, contact names, and telephone numbers.

4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.

5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.

b) Air Systems

c) Temperature Control Systems

d) Special Systems

e) Sound and Vibration Systems

5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE Std 111.

6. Units of Measure: Report data in I-P (inch-pound) units only.

G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.04 QUALITY ASSURANCE

A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.

C. TAB Agency Qualifications:

1. Act as the single source of responsibility for TAB of the HVAC systems.
2. Staff the project at all times by qualified personnel.
3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.
4. Certified by one of the following Certification Associations:
    a) AABC (NSTSB): Associated Air Balance Council, National Standards for Total System Balance.
    b) NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
    c) TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.

D. TAB Supervisor and Technician Qualifications:

1. Certified by the same organization as TAB agency.
2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.

B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.

C. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer

design condition, and within 10 deg. F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

D. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.

F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.

G. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Motors and bearings are lubricated.
5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
6. Duct systems are clean of debris.
7. Fans are rotating correctly and belts have tension.
8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Volume dampers are installed at locations needed for balancing the air systems.
11. Access doors are closed and duct end caps are in place.
12. Air outlets are installed and connected.
13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
14. Air vents are operating freely.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.

B. Furnish all instruments required for testing, adjusting, and balancing operations.

1. Verify all instruments have been calibrated.
2. Furnish instruments as recommended by the manufacturer for the TAB application.
3. Furnish instruments that are best suited to the function being measured.
4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.

D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

F. Determine best locations in main and branch ductwork for most accurate duct traverses.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.

B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

C. Differential Space Pressure:

1. Positive Zones: Balance to within 0 to plus 10 percent supply air and 0 to minus 10 percent for exhaust and return air.
2. Negative Zones: Balance to within 0 to minus 10 percent supply air and 0 to plus 10 percent exhaust and return air.

3.05 RECORDING AND ADJUSTING

A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.

B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:

1. Dry bulb temperature.
2. Relative humidity.
3. Cloud cover.
4. Wind speed.
5. Time.

C. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

D. Ensure recorded data represents actual measured or observed conditions.

E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.

J. Seal ducts and piping and test and repair leaks.

K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

M. Check and adjust systems approximately six months after final acceptance and submit report.

N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.

O. Take all readings at eye level of the indicated value to prevent parallax.

P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

Q. Take measurements in the system where best suited for the task.

R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.06 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Check filters for cleanliness.

B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.

C. Verify volume dampers are installed at locations needed for balancing the air systems.

D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

E. Determine best locations in main and branch ductwork for most accurate duct traverses.

F. Place outlet dampers in the full open position.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

H. Lubricate all motors and bearings.

I. Check fan belt tension.

J. Check fan rotation.

K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.

L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

M. Measure air quantities at air inlets and outlets.

N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

O. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and minimum air flow rate.

V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.

W. Multi-Zone units with Mixing Dampers: Check for motorized damper leakage. Adjust air quantities with mixing dampers set first for design cooling, then at design heating.

X. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

Y. On fan powered VAV boxes, adjust air flow switches for proper operation.

Z. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:

1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.

2. Operate supply fan at design speed and measure the outdoor airflow.

3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.

4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.

5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.

6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.07 TESTING FOR SOUND AND VIBRATION

A. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards:

1. ASHRAE: ASHRAE Handbook, HVAC Applications Volume, Chapter “Sound and Vibration Control”, most current edition.

2. NEBB: "Procedural Standards for the Measurement and Assessment of Sound and Vibration."

B. Other than sound data, failure of an item includes a deviation of more than 10 percent from setpoint. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.

1. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

C. Prepare and submit report of recommendations for correcting any sound or vibration levels that are outside of manufacturer’s tolerances, ASHRAE standards and/or values specified in the contract documents.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping Insulation.

B. External Ductwork Insulation.

C. Equipment Insulation.

1.02 RELATED REQUIREMENTS

A. 23 0529 - Hangers and Supports for HVAC Piping and Equipment for insulation shields, pipe saddles, and high-density insulation inserts.

B. Division 23 Section “Metal Ducts” for duct liner insulation.

1.03 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.

C. Cold Duct: Ductwork that carries airflow with a minimum operating temperature less than 65 degrees F temperature.

D. Hot Duct: Ductwork that carries airflow with a minimum operating temperature greater than 75 degrees F temperature.

E. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.

F. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.

G. Exposed: Insulation that is visible from the occupied space.

H. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.

I. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.

J. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

1.04 SUBMITTALS

A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.

B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1. Exception: Exterior mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 PIPING INSULATION MATERIALS

A. Flexible Elastomeric:

1. Manufacturers:
   a) Aeroflex USA, Inc.
   b) Armacell LLC.
   c) K-Flex USA.
2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
   a) K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
   b) Minimum Service Temperature: Minus 297 degrees F
   c) Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
3. Factory Applied Jacket:
   a) Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.

B. Field-Applied Jacket:

1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
   a) Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
   b) Manufacturers:
      1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers.
      2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
      3) Or Approved Equal.
2. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diamter (in)	Minimum Aluminum Jacket Thickness, (in)	Finish

	Non-Rigid Insulation	Rigid Insulation	
<= 8	0.016	0.016	Stucco
<12	0.020	0.016	Stucco
<= 24	0.024	0.016	Stucco
<= 36	0.032	0.020	See Note 1
> 36	0.040	0.024	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

a) Banding:

1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.

2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

C. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.

D. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.

2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.

4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note a)

Insulation Application	**Insulation Permeability, Less than 4.0 per-in (Note b)**	**Insulation Permeability 4.0 or greater perm-in (Note b)**
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33F to ambient)	0.05	0.05

Insulation Application	Insulation Permeability, Less than 4.0 per-in (Note b)	Insulation Permeability 4.0 or greater perm-in (Note b)
Pipe and vessels (-40F to 32F)	0.02	0.02
Ducts (40F to ambient)	1.0	0.03

Notes:

Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.

a) Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

E. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

F. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

G. High Density Insulation Billets:

1. Flexible elastomeric: ASTM C534, Type 1.

2.02 EXTERNAL DUCTWORK INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
   a) CertainTeed Corp.
   b) Johns Manville.
   c) Knauf Insulation.
   d) Owens Corning.
2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.
   a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
   b) Minimum Service Temperature: Minus 20 degrees F
   c) Maximum Service Temperature: 450 degrees.
   d) Density:
3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
   a) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.

b) Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.

c) Color: White.

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a) Johns Manville.

b) Knauf Insulation.

c) Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

a) K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.

b) Minimum Service Temperature: 0 degrees F

c) Maximum Service Temperature: 450 degrees.

d) Density:

1) 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a) All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.

b) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.

c) Polypropylene Scrim Polyester (PSP): Polyester paper with glass fiber yarn and bonded to polypropylene, water vapor permeance of 0.02 perms.

d) Color: White.

C. Cellular Glass:

1. Manufacturers:

a) Owens Corning.

2. Insulation: ASTM C552, Type I, Grade 6, rigid closed glass cells, block form.

a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.

b) Minimum Service Temperature: Minus 450 degrees F.

c) Maximum Service Temperature: 800 degrees F.

d) Density: Minimum 6 pounds per cubic feet.

D. Polyisocyanurate:

1. Manufacturers:

a) Dyplast Products.

b) Johns Manville.

c) Approved equal.

2. Insulation: ASTM C591, Grade 2, Type IV for ASTM E84 25/50 compliance, Type I for ASTM E84 25/450 compliance; rigid board.

a) K-value: ASTM C518 or C177, maximum 0.2 at 75 degrees F.

b) Minimum Service Temperature: Minus 297 degrees F

c) Maximum Service Temperature: 300 degrees F.

d) Density: Maximum 6 pounds per cubic feet.

E. Flexible Elastomeric:

1. Manufacturers:

a) Aeroflex USA, Inc.

b) Armacell LLC.

c) K-Flex USA.

2. Insulation: ASTM C534, Grade 1, flexible elastomeric cellular rubber insulation, sheet form.

a) K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

b) Minimum Service Temperature: Minus 40 degrees F

c) Maximum Service Temperature: 180 degrees F.

3. Factory Applied Jacket:

a) Flexible Metal Cladding: Metallic factory-laminated cladding, 17.5 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.00 perms. Provide ArmaTuff or equal. Reference Duct Jacket Schedule in Part 3 of this specification for application of this jacket.

F. Field-Applied Jacket:

1. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.

a) Thickness: 0.032 inch sheet.

b) Finish: Smooth or Stucco. Reference Part 3 for jacket applications.

c) Joining: Longitudinal slip joints and 2 inch laps.

d) Fittings: 0.032 inch thick die shaped fitting covers with factory attached protective liner.

e) Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

2. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

   a) Water Vapor Transmission: 0.0 perms per ASTM E96.

   b) Puncture Resistance: Minimum 65 pounds per ASTM D1000.

3. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

G. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.

H. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.

2. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.

3. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38, Design Polymerics 3040, or equal.

4. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.

5. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.03 EQUIPMENT INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

   a) CertainTeed Corp.

   b) Johns Manville.

   c) Knauf Insulation.

   d) Owens Corning.

2. Insulation: ASTM C553, Type I and II or ASTM C547 Type II, flexible mineral fiber blanket.

a) K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.

b) Minimum Service Temperature: Minus 20 degrees F

c) Maximum Service Temperature: 450 degrees F for ASTM C553 Types I and II, 1200 degrees F for ASTM C547 Type II.

d) Density: Minimum 1.5 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch lap.

b) Color: White.

B. Flexible Removeable and Reusable Blanket Insulation:

1. Manufacturers:

a) Auburn Manufacturing.

b) Approved equal.

2. Insulation: ASTM C553, Type V, flexible, noncombustible.

a) Comply with ASTM C1695.

b) K-value: ASTM C518 or C177, maximum 0.37 at 100 degrees F.

c) Minimum Service Temperature: 32 degrees F

d) Maximum Service Temperature: 500 degrees.

C. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a) Johns Manville.

b) Knauf Insulation.

c) Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

a) K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.

b) Minimum Service Temperature: 0 degrees F

c) Maximum Service Temperature: 450 degrees.

d) Density: Minimum 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a) All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.

b) Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.

c) Color: White.

D. Field-Applied Jacket:

1. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.

a) Thickness: 0.032 inch sheet.

b) Finish: Smooth.

c) Joining: Longitudinal slip joints and 2 inch laps.

d) Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

E. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.

2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Foster 30-80, Childers CP-38, Design Polymerics 3040, or equal.

3. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.

4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.

C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.03 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

3.04 PIPING SYSTEM INSULATION INSTALLATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Cold Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
3. Provide high density insulation material under supports or pre-insulated supports.
4. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and Supports for HVAC Piping and Equipment" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
5. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
6. Secure all-service jacket with self-sealing longitudinal laps.
7. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

F. Hot Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.
2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.
3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.
5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.
6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.
7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.

8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.

10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.

J. Exterior Piping and Piping Exposed to Weather:

1. General: Provide piping jacket around insulation as scheduled in the Piping Jacket Schedule. Jacket material shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of pipe. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.

2. Polymeric Coating: Provide insulation shields so that the piping supports do not puncture, cut or break the jacket.

3. Rigid aluminum shell: Space attachment bands 12 inches on center and directly centered over end joints.

K. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.05 PIPING SYSTEM INSULATION SCHEDULE

A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.

B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.

C. Omit insulation on the following:

1. Hot piping within radiation enclosures or unit cabinets.

2. Cold piping within unit cabinets provided piping is located over drain pan.

3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil.

4. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.

D. Exterior Piping: Insulate all exterior HVAC piping with one of the following:

1. Flexible elastomeric, use high temperature formula for systems with operating temperature greater than 220 F (not acceptable for steam, steam condensate or hot water piping systems with temperatures above 300 F).

E. Piping in Unconditioned Spaces: Insulate all HVAC piping in unconditioned spaces (i.e. ventilated attics or crawl spaces) with one of the following:

1. Flexible elastomeric, use high temperature formula for systems with operating temperatures above 220 F. (not acceptable for steam, steam condensate or hot water piping systems with temperatures above 300 F).

F. Variable Refrigerant Flow (VRF) Piping:

1. Service:

a) All refrigerant piping in cooling only, heat pump, or heat recovery VRF systems.

b) Acceptable Insulation:

1) Flexible elastomeric.

3.06 PIPE INSULATION THICKNESS SCHEDULE

A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity: Conductivity, Btu·in./(hr·ft²·°F)	Insulation Conductivity: Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.): <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

1. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.

2. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} – 1]$ where

   a) T = minimum insulation thickness (in.),

   b) r = actual outside radius of pipe (in.),

   c) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,

   d) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature ($Btu \cdot in/hr \cdot ft^2 \cdot °F$); and

   e) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

3. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.

4. For piping that shall be installed below grade, reference 23 2113.13 - BURIED HYDRONIC AND STEAM PIPING.

5. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.07 PIPING JACKET SCHEDULE

A. Exposed piping:

   1. All-service jacket.

B. Exterior piping, piping exposed to weather and piping in unconditioned spaces:

   1. Polymeric Coating (flexible elastomeric insulation only).

   2. Semi-rigid PVC for outdoor application (flexible elastomeric insulation on refrigerant piping only).

   3. Rigid aluminum shell.

3.08 DUCTWORK INSULATION SYSTEM INSTALLATION

A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces.

D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.

F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.

I. Cold Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
3. Seal joints with vapor barrier tape.
4. Seal joints with vapor barrier mastic.
5. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
6. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
7. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:
    a) Install thermal break such as rigid board insulation between the support and duct.
    b) Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a

minimum of 12 inches from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.

c) If a support device similar to Unistrut is used, foam fill or stuff tube.

J. Hot and Neutral Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
3. Secure joints with staples, tape, or wires.
4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

K. Exterior Ductwork and Ductwork Exposed to Weather:

1. Slope ductwork or taper the insulation to ensure that water drains off the duct and does not pond anywhere on the duct. Provide thickness of insulation around the entire duct that meets the specified thermal performance.
2. Jackets shall be approved by the jacket manufacturer for use with the specific insulation material it covers.
3. Locate longitudinal seams of jacket at bottom of duct. Install jacket in strict conformance with cladding manufacturer's instructions.
4. Seal joints with vapor barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified.
5. Install aluminum jacket with three metal jacket bands per section.
6. Cover seams in flexible metal cladding with ArmaTuff seal tape or equal.

3.09 DUCTWORK SYSTEM INSULATION SCHEDULE

A. Omit insulation on the following:

1. Lined ductwork that is interior to the building unless otherwise indicated on the drawings.
2. Interior ductwork with sound absorbing linings unless otherwise indicated on the drawings.

B. Prohibited insulation:

1. Polyisocyanurate installed within a return air plenum.

C. Supply Air:

1. Service:
    a) Supply ducts from air handling equipment.
2. Acceptable Insulation:
    a) Flexible mineral fiber.
    b) Rigid mineral fiber.
    c) Flexible elastomeric.

D. Return Air:
1. Service:
    a) Interior ductwork within 10 feet of exterior roof or wall penetrations.
2. Acceptable Insulation:
    a) Flexible mineral fiber.
    b) Rigid mineral fiber.
    c) Flexible elastomeric.

E. Exhaust Air.
1. Service:
    a) Interior ductwork within 10 feet of exterior roof or wall penetrations.
    b) Dishwasher exhaust ducts within 10 feet of discharge to the outdoors.
2. Acceptable Insulation:
    a) Flexible mineral fiber.
    b) Rigid mineral fiber.
    c) Flexible elastomeric.

F. Range and hood grease exhaust ductwork: Refer to Section “Air Duct Accessories” for requirements of fire-rated wrap insulation for grease exhaust duct.

G. Exterior Ductwork:
1. Service:
2. Acceptable Insulation:
    a) Cellular glass.
    b) Polyisocyanurate.
    c) Flexible elastomeric.

d) Omit insulation on phenolic foam ductwork and fittings. Refer to Division 23 Section "Nonmetal Ducts."

3.10 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

A. Flexible Mineral Fiber:

1. Interior Ductwork:

a) 0.75 pounds per cubic foot density:

1) 2-1/4 inch thick, minimum R-6.0.

b) 1.5 pounds per cubic foot density:

1) 2 inch thick, minimum R-6.0.

c) Meet R-value installed at maximum 25% compression, application limited to concealed locations.

B. Rigid Mineral Fiber:

1. Interior Ductwork:

a) 1.5 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-6.0.

b) 3 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-6.0.

c) 6 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-6.0.

2. Ductwork installed in machine, fan, and mechanical equipment rooms:

a) 2 inch thick, minimum R-8.0.

3. Exterior Ductwork or Ductwork Exposed to Weather:

a) 2 inch thick, minimum R-8.0.

4. Ductwork in an Unconditioned Space:

a) 1-1/2 inch thick, minimum R-6.0.

C. Cellular Glass:

1. Interior Ductwork:

a) 2 inch thick, minimum R-6.0.

2. Exterior Ductwork or Ductwork Exposed to Weather:

a) 2-1/2 inch thick, minimum R-8.0.

3. Ductwork in an Unconditioned Space:

a) 2 inch thick, minimum R-6.0.

D. Polyisocyanurate:

1. Interior Ductwork:
    a) 1 inch thick, minimum R-6.0.
2. Exterior Ductwork or Ductwork Exposed to Weather:
    a) 1-1/2 inch thick, minimum R-8.0.
3. Ductwork in an Unconditioned Space:
    a) 1 inch thick, minimum R-6.0.

E. Flexible Elastomeric:
1. Interior Ductwork:
    a) 1-1/2 inch thick, minimum R-6.0.
2. Exterior Ductwork or Ductwork Exposed to Weather:
    a) 2 inch thick, minimum R-8.0.
3. Ductwork in an Unconditioned Space:
    a) 1-1/2 inch thick, minimum R-6.0.

3.11 DUCTWORK JACKET SCHEDULE

A. Omit jacket on internally lined ductwork.

B. Exposed ductwork within mechanical rooms (below 10 feet):
1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Aluminum with smooth finish.

C. Exposed ductwork within mechanical rooms (above 10 feet):
1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).

D. Exposed ductwork:
1. Polypropylene Scrim Kraft (PSK).
2. All-Service Jacket (ASJ).
3. Polypropylene Scrim Polyester (PSP).

E. Ductwork within return air plenums:

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Flexible Metal Cladding (flexible elastomeric only).

F. Exterior ductwork and ductwork exposed to weather:

1. Flexible Metal Cladding (flexible elastomeric only).
2. Aluminum with stucco finish.
3. Multilayer Laminate Vapor Barrier Cladding.
4. Rubberized Asphalt Vapor Barrier Cladding.

3.12 EQUIPMENT INSULATION INSTALLATION

A. Install insulation subsequent to painting, testing, and acceptance of tests.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Protect insulation to prevent puncture and other damage.

D. Exposed Equipment: Locate insulation and cover seams in least visible locations.

E. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

F. Do not apply insulation to equipment, breechings, or stacks while hot.

G. Do not insulate flanges and unions of equipment carrying fluids less than 105 degrees F.

H. Provide neatly beveled edge at interruptions of insulation.

I. Fasten insulation to equipment with studs, pins, clips, adhesives, wires, or bands.

J. Stagger insulation joints for both single and double layer application, where feasible. Apply each layer of insulation separately. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

K. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

L. Cover insulated surfaces with jacketing, factory or field applied, neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

M. Cold Equipment:

1. Insulate entire system, including flanges and unions. Maintain continuous vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

2. Provide vapor barrier jacket, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.

3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

N. Hot Equipment:

1. Insulate entire system, including flanges and unions.

2. Provide jacket, with or without vapor barrier, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Omit Insulation on the following:

1. Factory pre-insulated equipment.

B. Do not apply insulation to equipment that operates outside of the minimum and maximum service temperature range.

C. Provide flexible removable and reusable blanket insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

3.14 EQUIPMENT JACKET SCHEDULE

A. Omit jacketing on equipment pre-insulated and jacketed from the factory.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Commissioning process requirements for HVAC systems, assemblies, and equipment.

1.02 SUMMARY

A. Commissioning Authority

1. Retain the services of a third -party registered design professional or approved agency that is regularly engaged in conducting commissioning to perform the duties of the Commissioning Authority including development of the commissioning plan, supporting documentation, and reports.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CxA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system and its appurtenances shall be commissioned.

1. Noise control devices.

2. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.03 RELATED REQUIREMENTS

A. Division 01 Commissioning requirements that apply to all types of work.

1.04 REFERENCE STANDARDS

A. ASHRAE Guideline 0 - The Commissioning Process, most current edition.

B. ASHRAE Guideline 1.1 - Application of the Commissioning Process to New HVAC&R Systems; 2025.

1.05 DEFINITIONS

A. Refer to Division 01 “General Commissioning Requirements” for additional abbreviations and definitions.

B. BAS: Building Automation System.

C. Basis of Design (BOD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

D. Commissioning Authority (CxA): An entity who coordinates the commissioning team to implement the Commissioning Process.

E. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.

F. Commissioning Process: A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the OPR. Commissioning is intended to achieve the following objectives:

1. Verify that applicable systems and equipment are designed and installed according to the manufacturer’s recommendations and to industry accepted minimum standards.
2. Verify that applicable systems and equipment receive adequate operational checkout by installing contractors.
3. Verify and document proper performance of equipment and systems.
4. Verify that O&M documentation provided to the Owner is complete.
5. Verify that the Owner’s operating personnel are adequately trained.

G. Commissioning Report: A report that includes the following:

1. Results of final functional performance tests. Organize equipment and components specified by other Divisions in separate sections for independent review.
2. List of functional performance testing procedures used during commissioning, including measurable criteria for test acceptance.
3. Itemization of resolved deficiencies found during preliminary commissioning.
4. List of deferred tests that cannot be performed at the time of final commissioning report preparation because of climatic conditions.

H. Functional Performance Test (FPT): A test that verifies the equipment or item being tested performs in the manner intended.

I. Owner's Project Requirements (OPR). A document that details the functional requirements of a project and the expectations of how it will be used and operated, including the following:

1. Project goals.
2. Energy efficiency goals.
3. Ventilation requirements.
4. Project documentation requirements
5. Facility functions.
6. Hours of operation and any need for after-hours operation.
7. Equipment and system expectations.
8. Building envelope performance expectations.
9. Measurable performance criteria.
10. Cost considerations.
11. Benchmarks.
12. Success criteria
13. Supporting information.

J. Operations and Maintenance Manual (O&M): A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operation of the building.

K. Pre-Functional Checklist (PFC): A checklist that verifies all components and accessories related to a system that will be subjected to an FPT are present and functional.

L. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

M. TAB: Testing, Adjusting, and Balancing.

1.06 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Authority informed of all changes to the HVAC system documentation made during installation and startup; revise and resubmit when substantial changes are made.

B. Submit a commissioning plan that includes the following:

1. General project information and commissioning goals.

2. Commissioning team information.

3. Narrative description of commissioning process activities, schedules, responsibilities, and personnel required during commissioning.

4. List of equipment and systems to be tested with description of tests to be performed. Include an explanation of the original design intent.

5. List of functions to be tested, including calibration and economizer controls.

6. List of conditions under which the tests shall be performed.

7. List of measurable criteria for performance.

C. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:

1. System name.

2. List of devices.

3. Step-by-step procedures for testing each controller after installation, including:

a) Process of verifying proper hardware and wiring installation.

b) Process of downloading programs to local controllers and verifying that they are addressed correctly.

c) Process of performing operational checks of each controlled component.

d) Plan and process for calibrating valve and damper actuators and all sensors.

e) Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.

5. Description of the instrumentation required for testing.

6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.

D. Submit startup reports, prefunctional checklists, and trend logs for review by the Commissioning Authority.

E. Submit a copy of the preliminary commissioning report. Preliminary commissioning report shall include the following:

1. Results of preliminary functional performance tests. Organize equipment and components specified by other Divisions in separate sections for independent review.
2. List of functional performance testing procedures used during commissioning, including measurable criteria for test acceptance.
3. Completed Commissioning Compliance Checklist.
4. Itemization of deficiencies found during testing that have not been corrected at the time of preliminary commissioning report preparation.
5. List of deferred tests that cannot be performed at the time of preliminary commissioning report preparation because of climatic conditions.
6. List of climatic conditions required for the performance of the deferred tests.

F. Submit a final commissioning report that includes the following:

1. Results of final functional performance tests. Organize equipment and components specified by other Divisions in separate sections for independent review.
2. List of functional performance testing procedures used during commissioning, including measurable criteria for test acceptance.
3. Itemization of resolved deficiencies found during preliminary commissioning.
4. Submit report to the Engineer and Owner within 90 days of the date of receipt of the certificate of occupancy.

G. Project Record Documents:

1. Submit as-built drawings indicating changes that occurre during the construction phase.
2. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
3. Show actual locations of all sensors on project record drawings.

H. O&M Manual: The O&M manual shall expand upon the more traditional operating and maintenance documentation to include information gathered during the commissioning process. Include the following for each system:

1. Manufacturer information.
2. Equipment specifications and recommendations.
3. Programming procedures and data points.
4. Narratives.

5. Other means of illustrating to the Owner how the building, equipment, and systems are intended to be installed, maintained, and operated.

6. Label that includes required regular maintenance actions for equipment and systems.

    a) Include in the label the title or publication number for the O&M manual for the model and type of product.

7. Site information, including facility description, history, and current requirements.

8. Site contact information.

9. Description of major systems.

10. As-built control schematics for each commissioned system.

11. As-built control sequences for each commissioned system, including final setpoints and list of all control points.

12. Final parameters of all peripheral equipment (e.g., final parameters resident in a VFD).

13. Recommended operating procedures for each piece of primary equipment.

14. Instructions for integrated building systems.

15. Instructions for basic troubleshooting.

16. Recommended schedule of maintenance requirements and frequency, troubleshooting guidelines, and emergency procedures.

17. Site equipment inventory and maintenance notes.

18. Site events log.

19. Copy of all special inspection verifications required by the enforcing agency or standards.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing. Unless otherwise noted such testing equipment will NOT become the property of Owner.

B. If not otherwise specified, provide test equipment certified and calibrated within the past year of use. Meet the following minimum accuracy requirements:

1. Temperature sensors and thermometers: Accuracy of plus/minus 0.5 degrees F and resolution of plus/minus 0.1 degrees F.

2. Pressure sensors: Accuracy of plus/minus 2.0 percent of value within the range of values being measured (not full range of sensor).

C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work. Such equipment, tools, and instruments shall become the property of Owner.

PART 3 - EXECUTION

3.01 COMMISSIONING PROCESS OVERVIEW

A. The following narrative provides a brief overview of the typical commissioning tasks performed during the design, construction, acceptance, and post-occupancy phases and the general order in which they occur. Coordinate with the CxA to comply with the commissioning requirements of the project.

1. Owner furnishes documentation to support the OPR and BOD to the design team and CxA.
2. The CxA holds a design review kickoff meeting.
3. The design team prepares construction documents to meet the OPR and BOD.
4. The CxA develops the commissioning plan.
5. The CxA conducts a construction document checklist review.
6. Plans are permitted and construction-related submittals for all commissioned equipment are provided to the CxA during the normal submittal process.
7. The CxA develops specific equipment PFCs and furnishes them to the contractor.
8. The CxA conducts a kick-off meeting early during construction and presents the commissioning process for the project.
9. The Contractor coordinates project construction and prepares the project for inspecting, acceptance testing, and PFCs.
10. The Contractor coordinates with the CxA to execute and document the PFCs. The CxA reports on the PFC process including an issues report.
11. PFCs are completed before start-up, testing and balancing, and functional testing.
12. The Contractor and responsible subcontractors shall document equipment start-up and initial checkout with assistance from manufacturer's technicians. The CxA may request copies of the manufacturer's or contractor's field start-up reports.
13. The CxA develops specific FPT plans for review by the Engineer, Contract Administrator and responsible subcontractors.
14. The Contractor coordinates TAB for the project.

15. Testing, adjusting and balancing of completed HVAC systems is completed and verified by the CxA.

16. The Contractor and responsible subcontractors complete the installation and checkout of all building control systems.

17. The CxA coordinates and executes the FPTs with the assistance of responsible subcontractors. The CxA reports on the testing process including all observed deficiencies.

18. The CxA develops a preliminary commissioning report.

19. Testing of other commissioned systems not requiring formal functional testing is completed.

20. The CxA reviews close-out documentation and schedules deferred testing.

21. The Contractor and CxA coordinate to compile the O&M manual.

22. The CxA verifies training as required by the Contract Documents is completed.

23. The CxA develops a final commissioning report.

3.02 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for use by the Commissioning Authority. Develop the following schedules and update the schedules as appropriate during the course of construction:

1. Leakage testing of duct systems.

2. Pressure testing of piping systems.

3. Flushing and cleaning piping systems.

4. Equipment startup.

5. Testing, adjusting, and balancing systems.

D. Notify the Commissioning Authority when scheduled tests will occur. When commissioning activities not yet performed or not yet scheduled will delay construction, notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

1. Provide a pressure/temperature plug at each water sensor that is an input point to the control system.

3.03 INSPECTING AND TESTING - GENERAL

A. Refer to the latest adopted edition of the applicable energy code for more information.

B. Coordinate appropriate acceptance testing technicians to perform required acceptance tests and complete documentation for acceptance testing.

3.04 PREFUNCTIONAL CHECKOUT

A. Submit startup plans, startup reports, and PFCs for each item of equipment or other assembly to be commissioned.

B. PFCs shall demonstrate the commissioned equipment is properly installed and ready for startup and initial operation.

C. Perform the PFCs directed by the CxA for each item of equipment or other assembly to be commissioned.

D. Document items from the PFCs and startup that were not completed successfully.

E. Complete and submit all PFC forms and provide notice that the equipment is ready for testing, adjusting, and balancing.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.05 TESTING AND BALANCING COORDINATION

A. Coordinate commissioning schedule with TAB schedule.

B. Notify the CxA at least 7 days in advance of testing and balancing work. Provide access for the CxA to witness test TAB work.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. All required Prefunctional Checklists, calibrations, startup, and component Functional Tests of the system shall be completed and approved by the CxA prior to starting TAB.

E. Coordinate with the BAS and TAB contractor to make available technicians, instrumentation, and tools to assist the CxA in verification of data points associated with TAB of HVAC systems.

3.06 FUNCTIONAL PERFORMANCE TESTING

A. The CxA shall submit FPT procedures to the subcontractors and equipment manufacturers for review for feasibility, safety, equipment, and warranty protection.

B. Perform the FPTs directed by the CxA for each item of equipment or other assembly to be commissioned, including equipment, controls, and economizers. FPTs shall demonstrate the following:

1. The operation, function, and maintenance serviceability for each commissioned equipment, component, and system is confirmed according to the approved plans and specifications.
2. The sequence of operations, including modes, backup modes (if applicable), alarms, and mode of operation upon a loss of power and restoration of power for each control device, equipment, component, and system. Reference section Control System Functional Testing below for more information.
3. Control devices, components, equipment, and systems are calibrated, adjusted, and operate in accordance with the approved plans and specifications.
4. Air economizers operated in accordance with manufacturer's specifications and specified sequence of operation.
5. Terminal units: For multiples of like equipment (VAV terminal units, unit heaters, etc.), commission a minimum of 50 percent of total number of units.

C. Coordinate with the responsible sub-contractors to provide trained technicians to perform commissioning tests and/or coordinate with equipment manufacturers to make available authorized technicians for the same purpose.

D. Test equipment under design conditions when possible. Impose simulated design conditions using an artificial load when it is not practical to test under design conditions. Provide additional equipment to impose simulated loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

1. The CxA may direct that setpoints be altered when simulating conditions is not practical.
2. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering setpoints are not practical.

E. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

F. If the Commissioning Plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

G. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.07 DEFERRED AND SEASONAL TESTING

A. If any PFC or FPT cannot be completed due to an unforeseen condition not within control of the Contract Administrator, defer execution of the PFC or FPT based on the recommendation of the CxA and approval of the Owner. Complete the affected testing as soon as practical.

B. During the warranty period, complete tests purposely delayed until weather conditions are closer to the system's design conditions. The CxA shall coordinate this activity. Any final adjustments to the O&M manuals and/or as-built drawings due to the testing shall be made by the CA.

3.08 OPERATION AND MAINTENANCE MANUALS

A. See Division 01 and Section 23 0010 - GENERAL MECHANICAL REQUIREMENTS for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.09 DEMONSTRATION AND TRAINING

A. See Division 01 for additional requirements.

B. Complete all related commissioning requirements prior to final inspections.

C. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

D. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

E. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned.

F. Provide the services of manufacturer representatives to assist instructors where necessary.

G. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

H. Document systems operations training in the commissioning report.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Control panels.

B. Control dampers.

C. Operators.

D. Humidistats.

E. Input/Output sensors and transmitters.

F. Output control devices.

G. Power Supplies.

H. Thermostats.

I. Time clocks.

1.02 DEFINITIONS

A. BAS: Building Automation System.

B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

C. Cv: Design Valve Flow Coefficient.

D. DDC: Direct Digital Control.

E. EPDM: Ethylene Propylene Diene Monomer.

F. High voltage: 50 volts or higher.

G. Low voltage: Below 50 volts.

H. PTFE: Polytetrafluoroethylene.

I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

J. Monitoring Meter: A water meter for determining water usage by a building system.

K. Sub meter: A water meter for determining water usage by a building tenant and used for billing purposes.

1.03 CONTRACTOR RESPONSIBILITIES

A. Reference 23 0015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT for contractor responsibilities.

B. BAS Contractor:

1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.
2. Low voltage control wiring.
3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of this wiring.
4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).
5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.
6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.
7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.
8. Perform startup and demonstration services as specified in Section “Direct Digital Control for HVAC”.

C. Sheet Metal Contractor:

1. Access doors where and as required.

D. Mechanical Contractor:

1. Installation of immersion wells.
2. Installation of pressure tappings and associated shut-off cocks.
3. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.04 SUBMITTALS

A. Refer to Division 01 for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Manufacturer's Instructions: Provide for all manufactured components.

E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

F. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

G. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.06 WARRANTY

A. Correct defective Work within a one year period after Substantial Completion.

PART 2 - PRODUCTS

2.01 CONTROL PANELS

A. Construction:

1. Panel shall be UL 508A listed.
2. NEMA 250, general purpose utility enclosures with enameled finished face panel.

3. NEMA 4X utility enclosure for outdoor or wash-down applications.

4. Provide common keying for all panels.

2.02 CONTROL DAMPERS

A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.

B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.

C. Performance: Test in accordance with AMCA 500-D.

1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:

a) Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.

1) Maximum velocity of 1,500 feet per minute.

2) Maximum Full-open air pressure drop of 0.1 inches W.C.

b) Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.

2. Leakage:

a) Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.

b) Motorized dampers for other applications shall be Class II leakage.

3. All control dampers used for smoke control shall conform to UL555S. Dampers that are installed in fire rated assemblies requiring fire rating shall also conform to UL555.

a) Fire/smoke dampers shall have fire resistance of 1-1/2 or 3 hours in accordance with UL 555 as required for the rated assembly that damper is installed.

1) Fire/smoke damper shall have elevated temperature rating of 250 F to remain open during smoke control operation.

b) Fire/smoke and smoke dampers shall be rated for Leakage Class I in accordance with UL555S and shall be rated for dual direction airflow.

D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.

1. Use minimum 16 gauge for rectangular dampers.

2. Use minimum 20 gauge for round dampers.

3. For aluminum frames, use 1/8 inch thick material.

4. All damper frames shall have a flange for duct mounting.

5. Reference Part 3 Execution for application of the material type.

E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.

1. Use minimum 16 gauge for rectangular dampers.

2. Use minimum 16 gauge for round dampers.

3. For aluminum blades, use 1/8 inch thick material.

4. The blades shall be suitable for the air velocities to be encountered in the system.

5. Dampers longer than the maximum blade length shall be fabricated in sections.

6. Reference Part 3 Execution for application of the material type.

F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.

1. Installed along the top and bottom of the frame and on all mating surfaces.

G. Jamb Seals: Spring stainless steel.

1. Installed inside the frame sides.

H. Shaft Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze.

2. Graphite impregnated nylon sleeve with thrust washers at bearings.

3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.

4. Molded synthetic bearings.

I. Linkage Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze

2. Graphite impregnated nylon.

J. Maximum Pressure Differential: 6 inches wg.

K. Temperature Limits: -40 to 200 degrees F.

L. Smoke Control Damper Accessories:

1. Fire/Smoke Damper:

a) Fire Stat: Provide UL classified dual temperature device that allows the damper to be re-opened after initial closure from high heat. Fire stat shall lock the damper closed when duct temperature exceeds temperature of 250 F. Fire stat shall allow the damper to remain operable from the control panel for smoke management purposes while air temperature is below the elevated temperature range specified herein.

b) Blade Position Indicator Switches: Provide two position indicator switches linked directly to the damper blade to enable remote indication of damper position.

c) Factory Sleeve: Provide minimum 20 gauge thick sleeve of length as required for the installation.

2. Smoke Damper:

a) Blade Position Indicator Switches: Provide two position indicator switches linked directly to the damper blade to enable remote indication of damper position.

b) Factory Sleeve: Provide minimum 20 gauge thick sleeve of length as required for the installation.

M. Manufacturers:

1. Greenheck.
2. CESCO.
3. Pottorff.
4. Nailor.
5. Ruskin.

N. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.

O. Extended Warranty: Control dampers utilized in an economizer assembly shall be covered with minimum 5 year manufacturer warranty, certified to operate through 60,000 damper opening and closing cycles, and certified to meet leakage requirements specified above.

2.03 OPERATORS

A. General:

1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.

a) Reference Part 3 for Damper Operator Voltage Schedule.

2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.

3. Construction:

a) For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

b) For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.

c) For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

4. Field Adjustment:

a) Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

b) Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.

6. Modulating Actuators:

a) Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.

b) Control Input Signal:

1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.

3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.

c) Programmable Multi-Function:

1) Control Input, Position Feedback, and Running Time: Factory or field programmable.

2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

7. Position Feedback:

a) Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

b) Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

c) Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.

8. Integral Overload Protection:

a) Provide against overload throughout the entire operating range in both directions.

b) Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

9. Attachment:

a) Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.

b) Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.

10. Temperature and Humidity:

a) Temperature: Suitable for operating temperature range encountered by application.

b) Humidity: Suitable for humidity range encountered by application, non-condensing.

11. Enclosure:

a) Suitable for ambient conditions encountered by application.

b) NEMA 4 for indoor wash-down or wet locations.

c) NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.

d) Provide actuator enclosure with heater and control where required by application.

12. Stroke Time:

a) Coordinate with stroke time indicated on the control drawings.

b) Unless otherwise noted, select operating speed to be compatible with equipment and system operation.

B. Damper Operators:

1. Controls contractor shall size damper operator.

2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

a) Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

b) Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.

c) Fail Positions:

1) Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.

(a) Return air damper, normally open.

(b) Outside air damper, normally closed.

(c) Exhaust/Relief air damper, normally closed.

2) Operator shall fail in place for all other applications not listed under spring return.

C. Manufacturers:

1. Damper Operators:

a) Belimo.

b) Honeywell.

c) Johnson Controls.

d) Schneider Electric (Invensys).

e) Siemens.

2.04 HUMIDISTATS

A. Room Humidistats:

1. Performance Characteristics:

a) Throttling range: Adjustable 2 percent relative humidity.

b) Accuracy: Plus/minus 3 percent over the operating range.

1) Accuracy shall include temperature effects.

c) Operating range: 20 to 80 percent.

d) Drift: Less than 1 percent per year.

2. Construction:

a) Wall-mounted enclosure: Plastic, NEMA 250, Type 1.

b) Cover: Set point indication.

3. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 - 10 Vdc signal..

B. Limit Duct Humidistat:

1. Insertion, two position switch type.

2. Performance Characteristics:

a) Throttling range: Adjustable 2 percent relative humidity.

b) Accuracy: Plus/minus 5 percent over the operating range.

1) Accuracy shall include temperature effects.

c) Operating range:

1) High Limit Type: Minimum 50 to 95 percent.

d) Drift: Less than 1 percent per year.

3. Construction:

a) Enclosure: Metal, NEMA 250, Type 1.

2.05 INPUT/OUTPUT SENSORS AND TRANSMITTERS

A. General:

1. Performance Requirements:

a) Device must be compatible with project DDC controllers.

b) Elements used shall be general-purpose type.

c) Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.

1) Transmitters and transducers shall have offset and span adjustments.

2) Shock and vibration shall not harm the transmitter or transducer.

3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.

d) Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.

2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 - 10 Vdc signal.

3. Input Power: Low voltage, nominal 24 Vdc.

B. Temperature Sensors:

1. General: Temperature sensing elements shall have characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.

2. Performance Requirements:

a) Thermistor:

1) Accuracy (All): Plus/minus 0.36 degrees F minimum.

2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degrees F minimum.

4) Heat Dissipation Constant: 2.7 mW per degree C.

5) Drift: 0.04 degree F after 10 years within temperature range.

b) RTD:

1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.

2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.

(a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.

(b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.

(c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degree F.

4) Drift: 0.04 degrees F after 10 years within temperature range.

c) Sensing Range:

1) Provide limited range sensors if required to sense the range expected for a respective point.

3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

4. Room Temperature Sensors:

a) Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.

b) Button Sensor for High Finish Spaces: Where noted on the drawings or scheduled, provide cable type, button probe sensor designed for flush mounting in wall or ceiling with the following features:

1) 6 inch leads.

2) 1/2 inch plastic spacer with locking nut.

3) Finish as specified on the drawings. If not specified, provide stainless steel finish.

c) Provide the following features:

1) Integral digital display with the following:

(a) Indication of space temperature.

(b) Setpoint adjustment to accommodate room setpoint.

(c) Manual occupancy override and indication of occupancy status.

(d) Controller mode status.

5. Temperature Averaging Elements:

a) Use on duct sensors for ductwork 10 sq ft or larger.

b) Use averaging elements where prone to stratification with sensor length range between 16-22 ft.

c) Provide for all mixed air and heating coil discharge sensors regardless of duct size.

6. Insertion Elements:

a) Use in ducts not affected by temperature stratification or smaller than 10 sq ft.

b) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.

c) Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.

C. Humidity Sensors:

1. Elements: Accurate within 3 percent full range with linear output.
    a) Accuracy shall include temperature effects.
2. Resolution: Plus/minus 1 percent.
3. Drift: Less than 1 percent full scale per year.
4. Sensing Range: 0 to 100 percent relative humidity.
5. Room Sensors: Provide housing with integral sensor. Housing shall be plastic, NEMA 250, Type 1. Provide with insulated backing suitable for exterior wall mounting.
    a) Cover: Provide display indicating sensed humidity value.
6. Duct Sensors: Insertion type probe with mounting plate. Housing shall be metal, NEMA 250, Type 1.
7. Outside Air Sensors: With element guard and mounting plate.

D. Pressure Transmitters:

1. Duct Static Pressure:
    a) Type: Unidirectional, fixed range.
    b) Performance Characteristics:
        1) Accuracy: Plus/minus one percent of full scale.
        2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.
        3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.
        4) Long Term Thermal Stability: Plus/minus one percent full scale per year.
    c) Construction:
        1) Insertion or traverse type sensor suitable for use in flat oval, rectangular, and round duct configurations.
        2) Insertion length selected as appropriate for duct size.
        3) Traverse sensors shall have at least one pickup point every 6 inches.
        4) Element: Variable capacitance sensing technology.
        5) Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.
2. Space Static Pressure:
    a) Type: Bi-directional, fixed range.

b) Performance Characteristics:

1) Accuracy: Plus/minus 0.5 percent of full scale.

2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.

3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.

4) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.

c) Construction:

1) Sensing Port Wall Mounting: Wall plate with integral sensor, sized to fit standard single gang electrical box. Back of sensor plate fitted with union fitting for tubing connection.

2) Sensing Port Ceiling Mounting: Round plate with union fitting for tubing connection.

3) Sensor Element: Variable capacitance sensor technology.

4) Sensor Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.

2.06 POWER SUPPLIES

A. Reference 23 0923 - Direct-Digital Control System for HVAC for DC power supply requirements.

B. Control power transformers shall meet NEMA/ANSI standards.

C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.

D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.

E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.

F. Performance Characteristics:

1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.

G. Provide a disconnect switch for each transformer.

2.07 THERMOSTATS

A. General:

1. Non-programmable with the following features:

a) Temperature information display.

b) Setpoint display and adjust.

c) Operation mode display and adjust.

d) Override.

e) Remote temperature sensor interface terminal.

f) Lockout.

2. Performance Requirements:

a) Accuracy: Plus/minus 1.0 degree F minimum.

b) Resolution: Plus/minus 0.2 degrees F.

c) Range:

1) Operating Temperature: 32 degrees F to 122 degrees F minimum.

2) Operating Humidity: 0 percent to 95 percent relative humidity, non-condensing.

3) Setpoint Control:

(a) Cooling: 54 degrees to 100 degrees F.

(b) Heating: 40 degrees to 90 degrees F.

d) Multi-stage as required to match unit cooling and heating stages scheduled on the drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

A. Install control valves, flow meters, operators, power supplies, output control devices, input/output sensors and transmitters in accordance with manufacturer's installation instructions.

B. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

C. Coordinate with other contractors performing work to provide emergency power to all control devices required to operate on emergency power.

1. Coordinate emergency power to BAS network control panels.
2. Coordinate emergency power to firefighter smoke control panel.
3. Coordinate power wiring for smoke control equipment is installed in metallic conduit.

D. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
3. Install all equipment in readily accessible locations.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Install all products in accordance with manufacturer's instructions.

E. Sensors:

1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
2. Provide thermistor type temperature sensors for temperature ranges between minus 30 degrees F to 230 degrees F. Provide RTD type temperature sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.
4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
5. Sensors used in mixing plenums and hot and cold decks shall be of averaging type. Averaging sensors shall be installed in a serpentine

manner vertically across the duct. Each bend shall be supported with a capillary clip.

6. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 feet downstream.

7. Install temperature, humidity, and smoke detectors for both supply air and return air applications a minimum of 10'-0" downstream or upstream of the air handling unit and prior to any branch duct takeoffs.

8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

9. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.

10. Differential air static pressure.

    a) Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.

    b) Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor or the plenum.

    c) Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building. Pipe the high-pressure port to a location suitable to sense common building pressure or as indicated on the drawings.

        1) Panel mount the transducer adjacent to its associated building automation system controller. Provide an independent manometer gauge next to transducer for calibration.

    d) The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

    e) All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

    f) All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

11. Verify location and mounting height of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Align with adjacent lighting switches and humidistats.

    a) Install devices to meet ADA requirements unless otherwise noted on the plans.

12. Mount freeze protection thermostats using flanges and element holders.

    a) Install thermostat completely across the surface the thermostat serves.

13. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

14. Provide separable sockets for liquids and flanges for air bulb elements.

15. Provide thermostats in aspirating boxes in areas where flush mounting is required.

16. Provide guards on thermostats in areas indicated on the drawings.

17. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

F. Flow Meters:

1. Install flow meters in a readily accessible location as shown on the plans with isolating valves on inlet and outlet.

2. Install differential pressure type flow elements with minimum straight lengths of pipe upstream and downstream from element in accordance with manufacturer's instructions.

3. Gas Meters: Furnish gas meter to Division 22 contractor for installation.

G. Control Dampers:

1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.

2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

3. Clearance:

    a) Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

    b) Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

4. Service Access:

a) Dampers and actuators shall be accessible for visual inspection and service.

b) Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in 23 3300 - Air Duct Accessories.

5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.

6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

8. Provide isolation (two position) dampers of parallel blade construction.

9. Provide opposed blade damper configuration for all other applications.

10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

H. Operators:

1. Mount and link control damper actuators according to manufacturer's instructions.

a) To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.

b) Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

c) Provide all mounting hardware and linkages for actuator installation.

2. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.

I. Control Panels:

1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.

2. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.

J. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

K. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

3.03 CONNECTIONS

A. Coordinate interlock of shutoff valves, operators, output control devices, input/output sensors, leak detection systems and transmitters where indicated on the drawings with the building automation system. Wiring and interlock with the building automation system are specified in Division 23 Section “Direct-Digital Control for HVAC”.

3.04 MAINTENANCE

A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

3.05 STARTUP AND DEMONSTRATION

A. Control Dampers and Valves:

1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.

5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

3.06 DAMPER SCHEDULE

Service	Ruskin Model	Material
Outside, Exhaust and Relief Air Control, Stairway and Shaft Vents	CD-50	Aluminum
Fire/Smoke Damper for Smoke Control	FSD-60	Galvanized Steel
Smoke Damper for Smoke Control	SD-60	Galvanized Steel
Corrosive Environments	CD-50-CE	Aluminum
Corrosive Environments	CD-36-CE	Stainless Steel
All Other	CD-356	Galvanized Steel

3.07 DAMPER OPERATOR VOLTAGE SCHEDULE

Service	Voltage
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

1. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. System description.

B. Operator interface.

C. Controllers.

D. Electrical Control Power Wiring and Low Voltage Wiring.

E. System software.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.03 DEFINITIONS

A. ASC: Application Specific Controller. Examples include controllers for specific applications (e.g., FCU, VAV box, etc.) that can be configured through any network services software.

B. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).

C. BAS: Building Automation System.

D. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.

E. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

F. DDC: Direct Digital Control.

G. EMT: Electrical Metallic Tubing

H. High voltage: 50 volts or higher.

I. IP: Internet Protocol.

J. LAN: Local Area Network.

K. VLAN: Virtual Local Area Network.

L. Low voltage: Below 50 volts.

M. NiCS: Niagara Compatibility Statement license.

N. OSI: Open System Interconnection

O. PC: Personal Computer.

P. PICS: Protocol Implementation Conformance Statement.

Q. Point: Point is a generic term used to describe a single item of information in a BAS. Points may be further described as input, output, digital, binary, discrete, analog, modulating, internal, external, virtual or global. Each unique point used by digital controllers, or in a BAS, is typically identified by an address.

1.04 CONTRACTOR RESPONSIBILITIES

A. Reference the following sections for additional contractor responsibilities and coordination:

1. 23 0015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT.
2. 23 0800 - Commissioning of HVAC.
3. 23 0913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.05 SUBMITTALS

A. Refer to Division 01 and 23 0010 - GENERAL MECHANICAL REQUIREMENTS for submittal procedures.

B. General:

1. The drawings and specifications are not intended to show all details. The BAS contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation for the devices and system described.
2. Inform Engineer in writing of any deviation in the exhibits submitted from the requirements of the drawings, specifications, and sequences of operations.

C. Product Data:

1. Submit manufacturer technical data for each system component and software module required for a complete installation.
2. Indicate dimensions, weights, and enclosure construction for all BAS distributed controllers.
3. Submit technical data on all new software supplied including description of functions performed by software and location within the system where software shall reside. Include all software licensing agreements.
4. Submit the PICS for each BACnet device used in the BAS.
5. Submit the NiCS for each type of Niagara station in the BAS.

D. Power and Communication Wiring Transient Protection:

1. Submit catalog data sheets providing evidence that all BAS products offered by the manufacturer are tested and comply with IEEE C62.41.2.
2. Testing shall include power and communication trunk wiring.
3. Compliance with IEEE C62.41.2 shall imply conformance with IEEE C37.90.1based on the stated position of ANSI and IEEE.

E. Shop Drawings:

1. Submit a trunk cable schematic showing locations of all programmable control units, controllers, and workstations, with associated network wiring.
    a) Indicate equipment served by each controller on the diagram.
    b) Indicate switches, power requirements to each controller, and daisy chained controllers.
    c) Indicate system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
2. Submit detailed schematic control drawings for each controlled device and equipment.
    a) Reference all control components to manufacturer make and model number.
    b) Include all control and power wiring with termination point (controller and terminal number).
    c) Include clearly indicated and written sequences of operation referenced to specific control components (e.g., "shall modulate valve V-3").
    d) Include default position (e.g., N.O., N.C., etc.) for all components where applicable.
    e) Clearly differentiate between existing components and new components.

f) Include detailed wiring diagrams showing methods of connections to VFDs, motor starters, energy meters, and all other devices, and all other field wiring necessary for system installation.

g) The use of ”typicals” will be allowed where appropriate.

3. Submit detailed drawings for each individual BAS distributed controller.

a) Include controller identification.

b) Include components included in the controller.

c) Include numbering of terminals and communications ports.

d) List connected data points, including connected control unit and input device.

e) Include type of cable connected to each terminal port.

f) Identify specific field devices wired to each terminal including identification of each field device and application.

g) Clearly differentiate between existing controllers and new controllers.

h) Indicate source (electrical panel ID) of 120V power to each panel to which 120V power is connected.

i) Indicate method of connecting controller to equipment supplied by others and to existing communications networks.

j) Indicate device instance and network number.

4. Submit floor plans that indicate the following:

a) Location of all new BAS distributed controllers and control panels.

b) Routing of all new building level network communications wiring not located in mechanical and electrical rooms.

c) Routing of wiring to controllers, sensors, and control points not located in mechanical and electrical rooms.

d) Location of building system connection to Owner’s campus wide data network.

5. Submit methods and materials used to integrate into existing networks.

6. All control drawings and schematics shall be generated using AutoCAD software or equivalent. All project drawings shall be supplied to the Owner in a format as desired by the Owner upon project completion.

7. Submit system identification nomenclature.

a) Nomenclature shall be consistent throughout the network and consistent with any existing networks that are integrated. If not defined, nomenclature shall be similar to the point names shown on the drawings.

b) Object name and ID number shall be unique within a control device.

c) Control device instance name and ID number shall be unique within the network.

d) Network number shall be unique for each unique electrical segment in the BAS.

8. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

a) Submit example graphic visualizations and screenshots for the BAS. At a minimum, submit examples for major HVAC equipment components, including chillers, boilers, air handling units, fan coil units, heat pumps, fans, etc.

b) Font size and type shall be manufacturer standard.

c) Provide graphics demonstration package in a format as desired by the Owner.

9. Indicate description and sequence of operation of operating, user, and application software.

F. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

G. Manufacturer's Qualification Statement.

H. Installer's Qualification Statement.

I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittals data in final "Record Documents" form.

3. All additions or changes to the BAS during the course of construction shall be reflected upon the drawings and submitted to the Engineer before project close-out.

J. Testing and Commissioning Reports and Checklists: Submit completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Startup and Demonstration.

K. Operation and Maintenance Data:

1. Include maintenance data and recommended spare parts list for digital control equipment and control components.

2. Include trouble-shooting maintenance guides.

3. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.

4. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

5. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

6. Include a maintenance manual which contains the information listed above, product data, shop drawings, final software code for sequences of operation and maintenance data in accordance with requirements of Division 01.

7. Include logbook for documentation of software updates and patches applied BAS for the time period included in the software licensing agreement.

8. Provide names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

L. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

M. Maintenance Materials:

1. Refer to Division 01 for additional provisions.

2. Extra Stock Materials: Two printer cartridges and cartons of printer paper.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. BACnet devices used in the BAS shall be BTL listed according to its device profile.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

E. Installer Qualifications: Company specializing in performing work of the type specified and with minimum documented experience as follows:

1. All personnel of the BAS Contractor shall have a minimum of three years of experience within their appropriate trades.

2. All subcontractors utilized by the BAS Contractor shall have a minimum of five years experience within their appropriate trades.

F. Additional BAS Contractor Requirements:

1. Emergency Service: The BAS Contractor shall have an established 24 hour emergency service organization. A dedicated telephone number shall be provided to the Owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BAS Contractor.

2. Parts Stocking: The BAS Contractor shall have an independently verifiable inventory of electronic service parts. This electronic service parts inventory must have a worth of at least $100,000 per year over the last five years.

3. Past Projects: The BAS Contractor shall have completed a minimum of five projects within the last five years which are at least equal in dollar value and comparable scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS Contractor if asked for by the Owner.

1.07 WARRANTY

A. Refer to Divsion 01 for additional project warranty requirements.

B. Labor and materials for the BAS specified shall be warranted free from defects in workmanship and material for a period of one year period after Substantial Completion and system acceptance.

C. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

D. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start data and period.

E. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner’s written authorization.

F. Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, wiring, and controllers that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system commissioning.

G. Provide five year manufacturer's warranty for field programmable micro-processor based units.

H. Special warranty on instrumentation:

1. All instrumentation shall be covered by manufacturer's transferable one-year "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.08 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

B. Software provider shall provide software updates and patches to the BAS as part of the software licensing agreement as the updates and patches are released. If any security vulnerabilities are discovered by the provider, the provider shall notify the client within five business days.

C. Ownership of Proprietary Material: Project-specific software and documentation shall become Owner's property upon project completion. This includes, but is not limited to the following:

1. Graphics.
2. Record drawings.
3. Database.
4. Application programming code.
5. Documentation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Niagara Framework Products: Products and stations supplied from the list of acceptable manufacturers in the following table shall be based on the latest version of the Niagara Framework and be supplied with an open NiCS license that shall not limit access or connectivity to the Niagara station in any way. Open access to the station shall allow any brand compatibility in and out of the station and tool compatibility in and out of the station.

1. Distech Controls: EC-Net.
2. Honeywell International, Inc: Webs.
3. Johnson Controls, Inc: Facility Explorer.
4. Siemens: Talon.
5. Approved equal.

2.02 SYSTEM DESCRIPTION

A. General:

1. The BAS shall consist of all necessary hardware and software to perform the control sequences of operation as called for in the Specifications and Drawings. Contractor shall install and commission all necessary devices to ensure a reliable and stable network.
2. System design is based on a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
3. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
4. The BAS shall be capable of integrating multiple devices, sensors, and functions from multiple control vendors into a common front end, including equipment supervision and control, alarm management, energy management, and trend data collection.
5. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.
6. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
7. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

B. Local Area Network:

1. The BAS shall be set up using a VLAN connection into the Owner’s internet or enterprise intranet. The VLAN shall be digitally separate from all other networks and shall share a common physical cabling backbone. Coordinate with the Owner to configure Ethernet and IP router switches to accommodate the VLAN.

C. Network Architecture: The BAS network architecture shall be based upon the OSI basic reference model in accordance with ISO 7498.

1. Application/Network Layer:
   a) BACnet protocol complying with ASHRAE Standard 135.
2. Physical/Data Link Layer:
   a) Hard-wired type:
      1) Ethernet according to ISO 8802-2 protocol.
      2) EIA-485 Twisted Cable Pair according to Master Slave/Token-Passing (MS/TP) protocol.

3. Communication between operator workstation(s) and building controller(s): Ethernet.

4. Communication between building controller(s) and application specific and custom applcation controllers: Ethernet or MS/TP.

D. Network Integration:

1. The BAS network shall be integrated with other automation networks controlled by the Owner. Coordinate with the Owner's information technology (IT) department for networks that shall be integrated.

2. Provide gateways or other integration devices across networks with different communication protocol to provide a single network visibility and interoperability at the operator workstation. Coordinate communication protocol with each automation system specified.

3. Interoperable networks shall be capable of sharing all point and point information across networks to a single BAS front end.

4. Interoperable networks shall be capable of automatically downloading application program changes.

5. For integrated networks that cannot automatically download application program changes, provide a link to the Controller Manual Download Schedule, as defined in the submittals section of Part 1 on the BAS front end summary page

6. Integrate the following networks:

a) Variable refrigerant flow building controllers.

E. Network Interoperability:

1. Provide communication between control units over local area network (LAN).

2. Communication services over the LAN shall result in operator interface and value passing that is transparent to the network architecture as follows:

a) Connection of an operator interface device to any one controller on the network shall allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.

b) All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the network. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to

set up any communication services to perform network value passing.

2.03 OPERATOR INTERFACE

A. General:

1. The Operator Interface shall provide overall BAS supervision and system software interface. Communications from the workstation shall be executed directly to and between the integration level building controllers and field level controllers.

2. The operator interface shall be capable of command entry, information and alarm management, database management, access of all system data, and be independent of hardware technology.

2.04 CONTROLLERS

A. Building Controllers:

1. General:

a) Input Power Requirements: 24Vac

b) Manage global strategies by one or more, independent, standalone, microprocessor based controllers.

c) Provide sufficient memory to support controller's operating system, database, and programming requirements.

d) Share data between networked controllers.

e) Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.

f) Utilize real-time clock for scheduling.

g) Continuously check processor status and memory circuits for abnormal operation.

h) Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

i) Communication with other network devices to be based on assigned protocol.

j) Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

a) Perform routing when connected to a network of custom application and application specific controllers.

b) Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a) Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.

b) Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:

a) Use for interrogating and editing data.

b) System security password prevents unauthorized use.

c) If the manufacturer does not normally provide a keypad and display for the controller, provide software and interface cabling needed to use a portable operator terminal for the system.

5. Provisions for Serviceability:

a) Diagnostic LEDs for power, communication, and processor.

b) Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

7. Power and Noise Immunity:

a) Maintain operation at 90 to 110 percent of nominal voltage rating.

b) Perform orderly shutdown below 80 percent of nominal voltage.

c) Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.

d) Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

8. Surge and Transient Protection:

a) Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b) Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

B. Application Specific Controllers:

1. General:
    a) Input Power Requirements: 24Vac.
    b) Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
    c) Customized for operation within the confines of equipment served.
    d) Provide sufficient memory to support controller's operating system, database, and programming requirements.
    e) Communication with other network devices to be based on assigned protocol.
        1) Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
    f) Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
2. Communication:
    a) Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
    a) Outdoors and/or in Wet Ambient Conditions:
        1) Mount within NEMA 4X waterproof enclosures.
        2) Rated for operation at 40 to 150 degrees F.
    b) Conditioned Space:
        1) Mount within NEMA 1 dustproof enclosures.
        2) Rated for operation at 32 to 120 degrees F and 95 percent RH, non-condensing.
4. Provisions for Serviceability:
    a) Diagnostic LEDs for power, communication, and processor.
    b) Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
    a) Maintain operation at 90 to 110 percent of nominal voltage rating.
    b) Perform orderly shutdown below 80 percent of nominal voltage.
    c) Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
7. Surge and Transient Protection:

a) Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE C62.41.2 IEEE Stan.

b) Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

C. Input/Output Interface:

1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.

2. All Input/Output Points:

a) Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.

b) Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

c) Universal-type inputs or outputs configurable between binary and analog are acceptable.

3. Binary Inputs:

a) Allow monitoring of On/Off signals from remote devices.

b) Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.

c) Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.

5. Analog Inputs:

a) Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).

b) Compatible with and field configurable to commonly available sensing devices.

6. Binary Outputs:

a) Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.

b) Outputs provided with three position (On/Off/Auto) override switches.

c) Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:

   a) Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.

   b) Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.

   c) Drift to not exceed 0.4 percent of range per year.

8. Tri State Outputs:

   a) Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.

   b) Limit the use of three point, floating devices to the following zone and terminal unit control applications:

      1) VAV terminal units.

      2) Duct mounted heating coils.

      3) Zone dampers.

      4) Radiant devices.

   c) Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

9. System Object Capacity:

   a) System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.

   b) Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Power Wiring: Copper wiring, plenum cable, and raceways shall be as specified in the applicable section of Division 26.

B. Power and Communication Wiring Transient Protection:

1. Comply with IEEE C62.41.2.

2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.

3. Communication circuitry, input/output circuitry, and communication unit shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations.

   a) For systems not complying with this requirement, provide equivalent protection external to the automatic temperature control system controller. Protection shall be provided for the individual

communications and input/output terminations for each automatic temperature control system controller.

b) Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

C. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.

2. Limit connected loads to 80 percent of rated capacity.

3. Match DC power supply to current output and voltage requirements.

4. Supplies shall be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.

5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.

6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.

7. Operational Ambient Conditions: 32 to 120 degrees F.

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.

9. Line voltage units UL recognized and CSA approved.

D. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.

2. Minimum surge protection attributes:

a) Dielectric strength of 1000 volts minimum.

b) Response time of 10 nanoseconds or less.

c) Transverse mode noise attenuation of 65 dB or greater.

d) Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

E. Input/Output Control Wiring

1. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.

2. In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.

3. Control wiring not installed in conduit shall be UL rated for plenum installation.

4. Ethernet control wiring shall be fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

5. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.

6. Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.

7. Binary control function wiring shall be a minimum of number 18 gauge.

8. Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.

9. Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.

10. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.

11. 120V control wiring shall be #14 THHN in 3/4 inch conduit. Provide 20% fill extra wire in each conduit.

F. Splices: Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding.

G. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: EMT with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

H. Relays

1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2. Solid State Relays (SSR):

a) Input/output isolation: Greater than 10 E^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz.

b) Contact Life: 10 x 10 E^6 operations or greater.

c) Ambient Temperature Range: Minus 20 to +140 degrees F.

d) Input impedance: Not be less than 500 ohms.

e) Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

3. Contactors:

a) Type: Single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts.

b) Positive locking shall be obtained without the use of hooks, latches, or semi permanent magnets.

c) The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

2.06 SYSTEM SOFTWARE

A. General:

1. Provide all necessary system software to form a complete operating system for all operator interface devices.

2. System software shall integrate with all controller software and allow management of software applications at the operator workstation.

3. System software display language: English.

B. Device Profile: BACnet devices shall Conform to the following device profiles as specified in ASHRAE/ANSI 135 BACnet Annex L:

1. Operator workstation: BACnet Operator Workstation (B-OWS).

2. Building Controller: BACnet Building Controller (B-C).

3. Application Specific Controller: BACnet Application Specific Controller (B-ASC).

C. Software Programming:

1. Provide programming for the system and adhere to the sequences of operation provided. Provide actions for all possible situations. All other system programming necessary for the operation of the system shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Provide text-based, graphic-based, and parameter-based programming where appropriate.

D. Operating System:

1. Concurrent, multi-tasking capability.
2. Common Software Applications Supported:
    a) Microsoft Windows and Office Suite.
    b) Open platform compatible database: Microsoft Access, Oracle Database, IBM Analytics, or other SQL database software. Proprietary databases shall not be acceptable.
3. Acceptable Operating Systems: Most recent version of operating system.

E. System Graphics:
1. Color type, saved in an industry standard format such as BMP, JPEC, PNG, or GIF.
2. Allow simultaneous display for comparison and monitoring of system status.
3. Web based graphics shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X, Java Virtual Machine, and Adobe Flash).
4. Animate displayed objects by shifting image files based on object status.
5. Functionality: Provide method for operator with password to perform the following:
    a) Move between, change size, and change location of graphic displays.
    b) Modify on-line.
    c) View a summary of the most important data for each controlled zone or piece of equipment.
    d) View a summary of the most important global data for the project, including but not limited to date, day of week, time, outdoor dry bulb temperature, and humidity.
    e) Use point-and-click navigation between graphic screens.
    f) Edit setpoints and other specified parameters.
    g) Edit equipment names and numbers.
    h) Edit room names and numbers.
    i) Indicate areas or equipment in an alarm condition using color or other visual indicator.
    j) Add, delete, or change dynamic objects consisting of:
        1) Analog and binary values.
        2) Dynamic text.
        3) Static text.
        4) Animation files.

k) Display graphic file, text, and dynamic object data together on a single graphic. Display all measured and commanded data, setpoints, calculated values, and input and output control points with appropriate engineering units associated with each system schematic.

l) Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

m) Dynamic Data Displays shall be capable of including point data from multiple ASC's.

6. Include at least one graphic for each of the following:

a) Each piece of equipment.

b) Occupied zone.

c) Hydronic system (chilled water, condenser water, hot water, steam, heat pump, etc.)

d) Floor plan displays of the building. Indicate summary conditions for each floor.

e) Indicate thermal comfort on floor plan using dynamic colors to represent zone temperature relative to zone setpoint.

7. Graphic Tree Structure:

a) Structure graphic system tree to allow access to individual graphic screens from a macro to a micro level.

b) Allow each level of graphic direct access to the graphic screen above and below the graphic screen in the system tree.

c) Allow direct access to the main summary graphic screen/map from any individual graphic screen.

8. Sequence of Operation Graphics:

a) Display the complete Sequence of Operation or include a link to a separate text file that contains the sequence of operation, as submitted by the Contractor and approved by the Engineer with each system schematic view. The Sequence of Operation text shall be in a separate frame above, below, or to the side of the graphic as appropriate for the graphic size and content.

9. Custom Graphics Generation Package:

a) Allow operator to create, delete, modify, and save graphic files and displays. File format of graphics shall be compatible with the BAS software.

b) Web-based Graphics: HTML graphics to support web browser compatible formats.

c) The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard components with which custom graphics may be built. Standard components include but are not limited to

1) Air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.).

2) Complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.).

3) Hydronic system components (e.g., chillers, boilers, pumps, piping, valves, etc.).

4) Electrical symbols.

d) The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following

1) Define symbols.

2) Position and size symbols.

3) Define background screens.

4) Define connecting lines and curves.

5) Locate, orient and size descriptive text.

6) Define and display colors for all elements.

7) Establish correlation between symbols or text and associated system points or other displays.

e) Graphical displays shall be capable of representing a group of objects. Groups shall be capable of representing any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the building.

10. Standard HVAC Graphics Library: Furnish a complete library of standard HVAC equipment graphics and standard symbols for ancillary equipment in a file format compatible with the graphics generation package program. Graphics shall include, but not be limited to, the following:

a) HVAC Equipment:

1) Air Handlers.

2) Terminal HVAC Units.

3) Fan Coil Units.

b) Ancillary Equipment:

1) Fans.

2) Dampers.

3) Ductwork.

F. Workstation System Applications:

1. General Application Functions:

a) All applications shall be capable of being executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization.

b) Allow BAS configuration and future changes or additions by operators with password protection.

c) Execute configured processes defined by the user to automatically perform calculations and control routines.

d) Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

1) Any system-measured point data or status

2) Any calculated data

3) Any results from other processes

4) Boolean logic operators (and, or)

e) Process Triggers: Configured processes may be triggered based on any combination of the following:

1) Time of day

2) Calendar Date

3) Other processes

4) Events (e.g., point alarms)

f) Data Access: A single process shall be able to incorporate measured or calculated data from any and all other ASC's. In addition, a single process shall be able to issue commands to points in any and all other ASC's on the local network.

2. Network Configuration:

a) Allow for configuration of the BAS network.

b) Provide alarm when a break in communication between devices is detected.

c) Enable the operator to add, delete, or modify the following:

1) Building controllers and ASC’s.

2) Points of any type, point parameters, and tuning constants.

d) Provide automatic reconfiguration if any station is added or lost.

3. Save and Restore:

a) Automatic System Database Save and Restore Functions:

1) Store current database copy of each Building Controller on hard disk or server.

2) Backup database on a user adjustable frequency basis. Default frequency shall be monthly.

3) Automatic update upon change in any system panel.

4) In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

b) Manual System Database Save and Restore Functions by Operator with Password Clearance:

1) Save database from any system panel.

2) Clear a panel database.

3) Initiate a download of a specified database to any system panel.

4. On-line Help:

a) Include context-sensitive system assists operator in operation and editing.

b) Include topics available for all applications.

c) Include relevant screen data provided for particular screen display.

d) Include additional help available via hypertext.

5. Security:

a) Require user name and password for operator log-on to view, edit, add, or delete data.

b) Include selectable system security for each operator. Support a minimum of five levels of access:

1) Level 1 = Read-only data access and display.

2) Level 2 = Level 1 + scheduling.

3) Level 3 = Level 2 + operator overrides and commands.

4) Level 4 = Level 3 + database generation and modification.

5) Level 5 = Level 4 + Audit trail management.

6) Operators shall be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined as accessible for the user.

7) Support a minimum of 4 passwords at each Building Controller.

c) Allow system supervisor to set passwords and security levels for all other operators.

d) Allow operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.

e) Include automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.

f) Store all system security data stored in encrypted format.

g) Log all user actions and store data for audit with permission access by system administrator only.

1) Include the modified system.

2) Include the value modified.

3) Include the time of modification.

6. System Diagnostics:

a) Operations Automatically Monitored:

1) Workstations.

2) Printers.

3) Network connections.

4) Building management panels.

5) Controllers.

b) Device failure is annunciated to the operator.

7. Alarm Management:

a) Allow alarm prioritizing to minimize nuisance reporting and to speed operator response to critical alarms.

1) Provide a minimum of three, user definable priority levels.

2) Enable users to manually inhibit alarm reporting for each point.

3) Enable users to manually inhibit nuisance alarm reporting for maintenance or repair work that is scheduled to be performed.

4) Enable user to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

5) Allow alarm prioritization to lock out or circumvent other alarms that may be generated as a result of primary alarm.

b) Prohibit interference with the ability of the system software to report alarms by either operator activity at the local I/O device, or communications with other system controllers on the network.

c) Allow all system objects are configurable to "alarm in" and "alarm out" of normal state.

d) Configurable Objects:

1) Alarm limits.

2) Alarm limit differentials.

3) States.

4) Reactions for each object.

5) Alarm delay.

8. Alarm Messages:

a) Descriptor: English language. Acronyms or mnemonics for objects in alarm are not acceptable.

b) Recognizable Features:

1) Source.

2) Location.

3) Nature.

4) Time and Date.

5) Alarm message box to more fully describe the alarm condition or direct operator response.

6) Each Alarm messages shall be assignable to any point in the BAS. Alarm messages shall be assignable to multiple points.

7) Notification of an alarm override.

9. Configurable Alarm Reactions by Workstation and Time of Day:

a) Logging.

b) Printing.

c) Starting programs.

d) Displaying messages.

e) Phone text message.

f) Email.

g) Providing audible annunciation.

h) Displaying specific system graphics.

10. Custom Trend Logs:

a) Maintain trend information for minimum 365 days.

b) Definable for any data object in the system including interval, start time, and stop time.

1) Resolution: Interval periods shall be adjustable down to one minute.

2) Multiple Interval Period: Each trended point shall have the ability to be trended at a different trend interval.

c) Trend Data:

1) Sampled and stored on the building controller panel.

2) Auto-Delete Period: Software shall be capable of automatically deleting stored trend data after a user-adjustable period of time. Each trended point shall have the ability to have a different auto-delete interval period.

3) Archivable on hard disk or server.

4) Retrievable for use in reports, spreadsheets and standard database programs.

5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

d) Trend Graph Display:

1) Group Trend Time Series Plots:

(a) Provide user-selectable Y-axis points.

(b) Provide user editable titles, point names, and Y-axis titles.

(c) Individual trended points shall be able to be grouped into groups of up to four points per plot with up to four plots per page.

2) X-Y Trend Plots:

(a) User selectable X and Y trend inputs.

(b) User editable titles, point names, and X and Y-axis titles.

(c) User selectable time period options:

(d) 1-day 24-hour period.

(e) 1-week 7-day period.

(f) 1-month period with appropriate days for the month selected.

(g) 1-year period.

(h) User shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.

(i) User selectable display up to 6 plots per screen in 2 columns.

3) Automatic Scaling: System shall automatically scale the axis on which trends are displayed when multiple points with different trend interval periods are selected for graphical display.

4) Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.

5) Zoom: Software shall allow zoom-in function for detailed examination of trends.

e) Numeric Value Display: Software shall display value of any sample on a trend when picked.

11. Alarm and Event Log:

a) View all system alarms and change of states from any system location.

b) List events chronologically.

c) List alarm priority.

d) Allow operator with proper security acknowledges and clears alarms. Log operator and time when alarm acknowledged.

e) Archive alarms not cleared by operator to the workstation.

12. Object, Property Status and Control:

a) Provide a method to view, edit if applicable, the status of any object and property in the system.

b) Status Available by the Following Methods:

1) Menu.

2) Graphics.

3) Custom Programs.

13. Clock Synchronization:

a) The real-time clocks in all building control panels and workstations shall be able to automatically synchronize daily from any operator-designated device in the system.

b) The system shall automatically adjust for daylight savings and standard time, if applicable.

14. Reports and Logs:

a) Reporting Package:

1) Allow operator to select, modify, or create reports.

2) Definable as to data content, format, interval, and date.

3) Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

4) Archivable to hard disk.

5) Provide ability to obtain real-time logs of all objects available by type or status such as alarm, lockout, normal, etc.

6) Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.

7) Allow printing on operator command or specific time(s).

b) Standard Report Format Options:

1) Global modification values.

2) Objects with current values.

3) Current alarms not locked out.

4) Disabled and overridden objects, points, and variables.

5) Objects in manual or automatic alarm lockout.

6) Objects in alarm lockout currently in alarm.

7) Objects currently in override status.

8) Objects in Schedules

(a) Daily.

(b) Weekly.

(c) Holiday.

9) Logs:

(a) Alarm History.

(b) System messages.

(c) System events.

(d) Trends.

c) Custom Report Format Options:

1) Daily.

2) Weekly.

3) Monthly.

4) Annual.

5) Time and date stamped.

6) Title.

7) Facility name.

8) Point groups: User selectable, comprised of specific points, groups of equipment objects, group of groups, or the entire facility without restriction due to hardware configuration of the BAS.

d) Tenant Override:

1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.

2) Annual report showing override usage on a monthly basis.

e) Electrical, Fuel, and Weather:

1) Electrical Meter(s):

(a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.

(b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

2) Fuel Meter(s):

(a) Monthly showing daily fuel consumption for each meter.

(b) Annual summary showing monthly consumption for each meter.

3) Weather:

(a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

15. Global Modify:

a) Allow global modification of all editable data. Similar data shall be grouped into logical objects based on building function, mechanical system, building layout, or any other logical grouping of points.

b) Allow each common type of equipment to be excluded or included within the global editing process.

c) Display status information on all similar points in one global report.

d) Allow modification of the following:

1) Individual data point edited.

2) List of all points within the category.

3) Global change field.

4) Copy feature to assist in downloading the new changes.

5) Verification that all changes were completed.

e) Include a change-all feature to change all selections.

f) Prevent acceptance of changes until an accept icon is acknowledged.

G. Workstation Applications Editors:

1. Provide editing software for each system application at PC workstation.
2. Edited applications shall be automatically downloaded and executed at the controller panel.
3. Programming Description: Definition of operator device characteristics, ASC's, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.
4. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.
5. System definition and modification procedures shall not interfere with normal system operation and control.
6. Provide consistent text-based displays of all system point and system applications.
7. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
8. Full screen editor for each application allows operator to view and change:
   a) Configuration.
   b) Name.
   c) Control parameters.
   d) Set-points.
   e) Schedules.
9. Scheduling:
   a) Allow scheduling down to the zone or room level.
   b) Monthly calendar indicates schedules, holidays, and exceptions.
   c) Allows several related objects to be grouped, scheduled, and copied to other objects or dates.
   d) Start and stop times adjustable from master schedule.
   e) Schedule expiration.
   f) Temporary overrides of systems with user adjustable time-out.
   g) Provide minimum three tiers of priorities for scheduling.
      1) Priority 1: Event, temporary, or override.
      2) Priority 2: Calendar.
      3) Priority 3: Default.

h) Higher priority schedules shall overlay with lower priority schedules without interrupting or deleting them. Upon expiration of a higher priority schedule, schedule shall revert to next lower priority.

i) Expired priority 1 and priority 2 schedules shall be automatically deleted after execution.

10. Custom Application Programming:

a) Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, and wiring are installed prior to installation proceeding.

E. Verify the integrity of control wiring, raceways, control panels, sensors, and control devices prior to reusing for the new work.

F. Verify wiring insulation is defect free and test wiring for continuity and ground faults.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Coordination:

1. The BAS Contractor shall execute their work in such a manner as to cause the minimum interference to the operation of the building.

2. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

3. Where the BAS shall share a common network backbone via a VLAN, provide temporary network access for BAS construction, startup, and commissioning. Coordinate transition of network operation to Owner's IT group.

4. Coordinate with the Owner to display additional virtual points on individual schematic graphic screens that are not directly associated with that system. Examples may include outdoor air temperature or global alarm conditions.

C. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Install all equipment in readily accessible locations.
3. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Control wiring routed in wall cavities shall be installed in conduit.
6. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
7. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

D. Controllers:

1. Install controllers in a locked control panel. Provide common keying for all controller covers.
2. Provide a separate controller for each piece of controlled equipment, such as an AHU, FCU, VAV box, etc. A controller may control more than one piece of equipment provided that all points associated with the equipment are assigned to the same BAS controller. Global points used for control loop reset are exempt from this requirement.
3. Select building controllers and custom application controllers to provide the required I/O point capacity required to monitor all of the hardware points listed on the control drawings.
4. Application specific controllers may be used where factory programming is capable of executing all control functions specified in the sequences of operation. Contractor shall add supplemental controllers, devices, and programming as required to execute the specified control function if the ASC cannot.

E. Wiring:

1. All control and interlock wiring shall comply with national and local electrical codes.
2. Properly ground all controllers.

3. Wire all safety devices through both hand and auto positions of motor starting device to ensure 100 percent safety shut-off.

4. Provide interlock wiring between devices as indicated on the control drawings.

5. Provide electrical wiring for relays (including power feed) for temperature and pressure indication.

6. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

7. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.

8. Conceal all low voltage wiring in finished rooms.

9. Conceal all low voltage wiring in unfinished rooms below the elevation of the lights. Low voltage wiring above the elevation of the lights may be exposed.

10. Routing of low voltage wiring above working heights in equipment rooms and above accessible ceilings is acceptable subject to following criteria:

    a) Wiring shall be plenum rated.

    b) Do not lay wiring on ceiling tiles.

11. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended applications.

12. All wiring in mechanical, electrical, service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.

13. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two wires (e.g., relays and transformers).

14. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.

15. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

16. All wire-to-device and wire-to-wire connections shall be made at a terminal block or terminal strip.

17. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

18. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, coordinate with Division 26 to provide step-down transformers.

19. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

20. Install plenum wiring in sleeves where it passes through floors and walls. Maintain fire rating at all penetrations.

21. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

22. Include one pull string in each raceway 1 inch and larger.

23. Use coded conductors throughout with conductors of different colors.

24. Control and status relays shall be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

25. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g., steam pipes or flues).

26. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

27. Install insulated bushing on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

28. Terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.

29. Terminate BAS sensor input wiring cable shield by taping back at the field device and connect shield to the grounded control panel chassis or sub-panel.

30. Terminate BAS comm bus cable shield between controllers per manufacturer recommendations.

31. Terminate management level/enterprise level network wiring cable shield by wrapping the drain wire around the foil shield and connecting the ground strip to the drain wire.

32. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than 1/2 inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

33. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections

shall be joined with couplings (according to code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

F. Communication Wiring:

1. Adhere to the items listed in the "Wiring" article in Part 3 of this specification in addition to the requirements listed below.
2. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication wiring.
3. Do not exceed 328 feet in Ethernet wiring length between switches or repeaters.
4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
5. Do not install power wiring, in excess of 30 Vac RMS, in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, use separate twisted shielded pairs with the shields grounded in accordance with the manufacturer's wiring practice.
6. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
7. Do not exceed maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer during installation.
8. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
9. When a cable enters or exits a building, install a lightning arrestor between the lines and ground. Install the lightning arrestor according to the manufacturer's instructions.
10. Ground (earth ground) all shields at one point only, to eliminate ground loops.
11. All runs of communications wiring shall be unspliced length when that length is commercially available.
12. Terminate shielded cable splices in accessible locations. Harness cables with cable ties.
13. Make all wire-to-device and wire-to-wire connections at a terminal block or terminal strip.
14. Label all communications wiring to indicate origination and destination data.
15. Ground coaxial cable in accordance with NEC regulations.

16. Install BACnet MS/TP communications wiring in accordance with ASHRAE/ANSI Standard 135

    a) The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 17 pF per foot at 76,800 Baud.

    b) The maximum length of an MS/TP segment shall be 3000 ft with AWG 22 or 24 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.

    c) The maximum number of nodes per segment shall be 50. Additional nodes may be accommodated by the use of repeaters.

    d) An MS/TP EIA-485 network shall have no T connections.

G. Identification of Hardware and Wiring:

1. Label all wiring and cabling, including that within factory-fabricated panels, at each end within 2 inch of termination with the BAS address or termination number.

2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.

4. Identify all other control components with permanent labels. Label all plug-in components such that removal of the component does not remove the label.

5. Identify room sensors related to terminal box or valves with nameplates.

6. Maintain manufacturers' nameplates and UL or CSA labels visible and legible after equipment is installed.

7. Identifiers shall match record documents.

3.03 STARTUP AND DEMONSTRATION

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing the BAS in permanent operation.

B. Contractor shall provide an on-site controls technician or programmer familiar with the project BAS installation and system programming to assist the Commissioning Agent as directed during all phases of system functional testing.

C. Coordinate with Owner the setup of logins, passwords, and security level access for individuals requiring access to the BAS.

D. BAS graphics shall be updated with final equipment names, equipment numbers, room names and room numbers to match the final construction documents and any Owner changes made prior to occupancy.

E. BAS shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the BAS equipment used in this project. Technicians shall be experienced in the type of HVAC systems associated with this project.

F. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

G. Test each control device to ensure that it is operating properly and is calibrated to the appropriate operating requirements. Run each control device through its range of operation and sequence. Verify all normal positions are correct. Adjust and tune PID control constants to achieve proper system operation.

1. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

2. Demand limiting. The Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

3. Optimum start/stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

4. Any tests that fail to demonstrate the operation of the BAS shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

H. Test and verify control interfaces to other building systems integrated into the network.

I. Verify all alarms and interlocks.

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

4. Verify fire/smoke and smoke damper functionality. Verify that they respond to the proper fire alarm system general, zone, and/or detector trips.

J. Document on system equipment schedules the final setting of controller PID constant settings, setpoints, manual reset values, maximum and minimum controller output, and ratio and bias settings in units and terminology specific to the controller. Store documentation with operator workstation.

K. Demonstrate complete and operating system to Owner.

1. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process.

3. The Contractor shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Any test equipment required to provide the proper operation shall be provided by and operated by the Contractor.

4. Demonstrate compliance with sequences of operation through all modes of operation.

5. Demonstrate complete operation of operator interface.

L. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Contractor and submitted for approval by the Owner. Such tests shall then be performed as part of the warranty.

2. The BAS shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.04 MAINTENANCE

A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.

3.05 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a

minimum of eight hours on the operation and maintenance of the equipment provided under this section.

B. Organize the training into sessions or modules for different levels of operators. Owner designated personnel shall be trained based on the level of operator training described below.

C. Day-to-day Operator Training:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Proficiently operate the BAS.
3. Understand BAS architecture and configuration.
4. Understand BAS components.
5. Understand system operation, including BAS control and optimizing routines (algorithms).
6. Operate the workstation and peripherals.
7. Log on and off the system.
8. Access graphics, point reports, and logs.
9. Adjust and change system set points, time schedules, and holiday schedules.
10. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
11. Understand BAS drawings and Operation and Maintenance manual.
12. Understand the job layout and location of control components.
13. Access data from BAS controllers and ASCs.
14. Operate portable operator's terminals.
15. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

D. Advanced Operator Training:

1. Make and change graphics on the workstation.
2. Create, delete, and modify alarms, including annunciation and routing of these.
3. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals.
4. Create, delete, and modify reports.
5. Add, remove, and modify system's physical points.
6. Create, modify, and delete programming.

7. Add panels when required.
8. Add operator interface stations.
9. Create, delete, and modify system displays, both graphical and others.
10. Perform BAS field checkout procedures.
11. Perform BAS controller unit operation and maintenance procedures.
12. Perform workstation and peripheral operation and maintenance procedures.
13. Perform BAS diagnostic procedures.
14. Configure hardware including PC boards, switches, communication, and I/O points.
15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
16. Adjust, calibrate, and replace system components.

E. System Manager/Administrator Training:

1. Maintain software and prepare backups.
2. Interface with job-specific, third-party operator software.
3. Add new users and understand password security procedures.

F. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

G. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

H. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Moisture and liquid indicators.

C. Valves.

D. Strainers.

E. Check Valves.

F. Pressure regulators.

G. Pressure relief valves.

H. Filter-driers.

I. Solenoid valves.

J. Expansion valves.

K. Flexible connections

1.02 SUBMITTALS

A. Product Data: Provide general assembly of valves and specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.

B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment.

C. Test reports specified in Part 3 below.

D. Manufacturer's Installation Instructions: Indicate support requirements, connection requirements and isolation requirements for servicing.

E. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.

F. Maintenance Data: Include maintenance instructions for refrigerant valves and piping specialties, for inclusion in Operation and Maintenance manual.

1.03 QUALITY ASSURANCE

A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, and maintain sealed until connected into system.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with ASME/ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.

B. Comply with ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.

C. Comply with applicable Mechanical Code.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated

2.02 PIPING

A. Copper Tubing:

1. ASTM B280, Type ACR, seamless, hard-drawn straight lengths and soft-annealed coils. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.
2. ASTM B88, Type L, seamless, hard-drawn straight lengths and soft-annealed coils.
3. ASTM B88, Type K, seamless, hard-drawn straight lengths and soft-annealed coils.

B. Refrigerant Line Kits:

1. Type ACR seamless copper roll of refrigerant tubing with pipe diameters as recommended by the manufacturer and of length as required for the installation.

2. Factory or field installed flexible unicellular insulation:

   a) Minimum thickness as required per Division 23 section “HVAC Insulation”.

3. Quick-connect flare tubing compression fittings or solder connections as required to match the connections of the condensing unit and evaporator coil.

2.03 FITTINGS

A. Wrought-Copper Fittings for Solder-joint: ANSI B16.22, streamlined pattern.

B. Mechanical Flared Fittings: ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tube.

2.04 JOINING MATERIALS

A. A. Refer to Division 23 Section “Basic Piping Materials and Methods” for joining materials.

2.05 PIPE SUPPORTS

A. Hanger, supports, and anchors are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing. Provide plastic galvanic isolators for copper tubing where indicated.

2.06 MOISTURE AND LIQUID INDICATORS

A. Manufacturers

1. Emerson Electric.
2. Henry Technologies.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Moisture/liquid Indicators: Single port type, UL listed, with forged brass body, solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; rated for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.07 SHUTOFF VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Henry Technologies.
4. Parker Hannifin/Refrigeration and air Conditioning.
5. Sporlan, Division of Parker Hannifin.

B. General: Complete valve assembly shall be UL-listed and designed to conform to AHRI 760. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

C. Diaphragm Packless Valves: Globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F

D. Ball: Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seal; maximum working pressure 500 psig and maximum temperature of 275 F.

E. Globe: Cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections; for maximum working pressure of 500 psig and maximum operating temperature of 275 deg. F.

2.08 STRAINERS

A. Manufacturers:
1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

B. Strainers: 500 psig maximum working pressure; forged brass body with Monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

2.09 CHECK VALVES

A. Manufacturers:
1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

B. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze or forged brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.

C. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

2.10 PRESSURE REGULATING VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Evaporator Pressure Regulating Valves: Pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tappings, 24 volts DC, 50/60 Hz, standard coil; and wrought copper fittings for solder end connections.

2.11 PRESSURE RELIEF VALVES

A. Manufacturers:

1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.12 FILTER DRIERS

A. Manufacturers:

1. Danfoss.
2. Emerson Electric
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows:

1. Standard capacity desiccant sieves to provide micronic filtration.
2. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

C. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

D. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets.

2.13 SOLENOID VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Valves: 250 deg. F temperature rating, 500 psig working pressure; forged brass body, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve.

C. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.

2.14 THERMOSTATIC EXPANSION VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Thermostatic Expansion Valves: thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, and an external equalizer line.

C. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select valve to avoid being undersized at full load and excessively oversized at part load.

2.15 FLEXIBLE CONNECTORS

A. Manufacturers

1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning
3. Sporlan, Division of Parker Hannifin

B. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length

PART 3 - EXECUTION

3.01 PIPE APPLICATION SCHEDULE

A. Above Grade:

1. Type L or Type ACR tubing.

B. Below Grade and Within Slabs:

1. Use Type K tubing for 2 inch and smaller without joints. Mechanical fittings (crimp or flare) are not permitted.
2. Install tubing in insulated PVC or HDPE protective conduit. Vent conduit to the outdoors.

C. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "CLEANING" below.

D. At contractor's option, use refrigerant line kits for refrigerant systems of 5 tons and smaller capacity.

3.02 PIPE IDENTIFICATION

A. Reference Division 23 Section "Identification for HVAC Piping and Equipment" for piping identification requirements.

3.03 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install piping to ASME B31.9 requirements.

C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

D. Do not install PVC or non-plenum rated HDPE piping in return air plenums.

3.04 PIPING INSTALLATIONS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration" and the equipment manufacturer's installation requirements.

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

C. Install piping for minimum number of joints using as few elbows and other fittings as possible.

D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

F. Insulate piping per Division 23 Section "HVAC Insulation."

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

G. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.
2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
4. Liquid lines may be install level.

J. Use fittings for all changes in direction and all branch connections.

K. For bendable copper tubing system, bend tubing in accordance with manufacturer's instructions using tools that are acceptable to the manufacturer.

L. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

M. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

N. Pipe Protection for Flammable Refrigerants: Protect refrigerant piping used for A2L and B2L refrigerants located in concealed locations where tubing is installed in studs, joists, rafters or similar member spaces and located less than 1.5 inches from the nearest edge of the member. Piping shall be continuously protected by protective shield plates having a minimum thickness of 0.0575 in (No. 16 gage) and shall cover the area of the tube and shall extend a minimum of 2.0 inches beyond the outside edge of the tube.

3.05 HANGERS AND SUPPORTS

A. Comply with the requirements of Division 23 Section “Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Provide insulation saddles and protection shields as specified in Section “Hangers & Supports for HVAC Piping & Equipment”. Provide insulation inserts as specified in Section “HVAC Insulation”.

C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size (in)	Max. Span (ft)	Min. Rod Size (in)
Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
4	12	1/2
6	14	5/8

D. Support vertical runs at each floor. Support riser piping independently of connected horizontal piping.

E. Install a support within one foot of each change of direction.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Vibration Isolation:

1. Resiliently support piping within 50 feet of connected rotating equipment that has scheduled capacity greater than 50 tons of cooling.

a) Suspend pipe using Type SPNM or Type SPNH isolators. Provide vibration isolation anchors and guides for pipe. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to 1.5 times that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 1 inch.

2. Reference section "Vibration Isolation for HVAC Piping and Equipment" for isolator definition.

3.06 PIPE JOINT CONSTRUCTION

A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.

3.07 VALVE AND PIPING SPECIALTIES INSTALLATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

C. Install a full sized, 3-valve bypass around each drier.

D. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.

E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.

1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.

2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.

3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.

4. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

F. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

G. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

1. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.

I. Install flexible connectors at the inlet and discharge connection of compressors.

3.08 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow servicing and maintenance.

3.09 FIELD QUALITY CONTROL

A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5. Provide test report summarizing the test procedures and results of the tests.

B. Repair leaking joints using new materials, and retest for leaks.

C. Field Test: Every refrigerant-containing part of every system that is erected on the premises, except safety devices, pressure gauges, control mechanisms, compressors, evaporators, and systems that are factory-tested, shall be tested and proved tight after complete installation and before operation. The high side and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high side and low side of the system, respectively.

D. Testing Procedure: Tests shall be performed with dry nitrogen. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gage on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system’s components.

3.10 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:

1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.

2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.

3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.

4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.11 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems in accordance with requirements of Division 23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.12 STARTUP

A. Charge system using the following procedure:

1. Install core in filter dryer after leak test but before evacuation.

2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.

3. During evacuation, apply heat to pockets, elbows, and low spots in piping.

4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.

5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.

6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 01 section "Closeout Procedures."

D. Schedule training with Owner through the Architect, with at least 7 days advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. VRF certification and training for piping installation and testing.

B. Pipe and tubing materials.

C. Fittings.

D. Refrigerants.

E. Valves.

F. Refrigerant Piping Specialties.

1.02 SUBMITTALS

A. Product data for the following products:

1. Each type valve specified.
2. Each type refrigerant piping specialty specified.

B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

C. VRF installer’s current training certificates signed by manufacturer’s designated training agent in compliance with requirements specified under "Quality Assurance" below.

D. Brazer's Certificates signed by Contractor certifying compliance with requirements specified under "Quality Assurance" below.

E. Test reports specified in Part 3 Article “Field Quality Control."

F. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operation and Maintenance Data specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.03 QUALITY ASSURANCE

A. Certified Piping Installers:

1. Certified by the manufacturer or manufacturer’s representative.

2. Present on-site during construction to provide supervision and quality assurance inspection of the VRF piping installation.

3. Quantity: Minimum of two.

B. If the certified training has not been completed within the last 12 months prior to the construction start date, the manufacturer or manufacturer's representative shall conduct a minimum 2 hour refresher training class.

C. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications".

D. Regulatory Requirements: Comply with provisions of the following codes:

1. ASME/ANSI B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

2. ASME/ANSI B16.26: Cast Copper Alloy Fittings for Flared Copper Tube

3. ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.

4. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.

5. Locally adopted mechanical code

E. Refer to Section "Basic Piping Materials and Methods" for additional requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating materials by leaving end caps, plugs, and coverings in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, and maintain sealed until connected into system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Refrigerant Valves and Specialties:

a) As furnished by the VRF equipment manufacturer or recommended by the VRF installation instructions.

2.02 REGULATORY REQUIREMENTS

A. Comply with ASME/ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.

B. Comply with ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration

C. Comply with applicable Mechanical Code.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.03 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATION" for identification of systems where the below specified pipe and fitting materials are used.

B. Copper Tubing:

1. ASTM B280, Type ACR, seamless, hard-drawn straight lengths and soft-annealed coils. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.

C. Refrigerant Line Kits:

1. Soft-annealed copper tubing, with pipe diameters as recommended by the manufacturer and of length as required for the installation.
2. Factory or field installed flexible unicellular insulation with minimum thickness as required per Division 23 Section “HVAC Insulation”.
3. Quick-connect flare tubing compression fittings or brazed connections as required to match the connections to the equipment.

2.04 FITTINGS

A. Wrought-Copper Fittings for Solder-joint: ANSI B16.22, streamlined pattern.

B. Mechanical Flared Fittings: ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tube.

2.05 JOINING MATERIALS

A. Refer to Division 23 Section “Basic Piping Materials and Methods” for joining materials.

2.06 REFRIGERANT

A. Refrigerant shall be R410A or R32, in accordance with ASHRAE Standard 34.

2.07 VALVES

A. General: Complete valve assembly shall be UL-listed and designed to conform to AHRI 760 and VRF manufacturer's installation requirements. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

B. Thermal Expansion Valves: The VRF equipment shall be furnished integral with thermal expansion valves unless otherwise noted. Coordinate refrigerant piping installation requirements with VRF manufacturer's installation instructions.

C. Ball Valves: Two-piece, complying with MSS SP-110, with 700 psi maximum operating pressure, a working temperature range of minus 40 to plus 300 degrees F, cast bronze body according to ASTM B584, bronze trim, brazed ends, PTFE seat and seal, blowout-proof stem, and full port ball. Valve body shall be hermetically sealed. Bolted body valves are not permitted. Provide Sporlan EBV series or approved equal.

D. Check Valves: Two-piece, with 700 psi maximum operating pressure, a working temperature range of minus 40 to plus 300 degrees F, cast bronze or forged brass body, brazed ends, and PTFE seal and seat. Provide Mueller CheckMaster Four Bolt or approved equal.

2.08 REFRIGERANT PIPING SPECIALTIES

A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to AHRI 760 and VRF manufacturer's installation requirements.

B. Strainers and or Filters shall be provided integral with VRF equipment unless otherwise noted. Coordinate refrigerant piping installation requirements with VRF manufacturer's installation instructions.

C. Suction Line Filter Assembly: Sidestream filter assembly, complete with replaceable minimum 10 mesh filter element, ball valves for filter isolation, bypass isolation, and check valve upstream of filter. Assembly size shall match condensing unit suction pipe size.

1. Manufacturers:

a) Sporlan.

b) Approved equal.

PART 3 - EXECUTION

3.01 PIPE APPLICATIONS

A. Heat Pump Applications:

1. Hard tubing between the outdoor unit and indoor units.

2. Soft tubing may be used for systems with a total cooling and heating capacity of 5 tons and smaller.

3. Soft tubing may be used for final connection between the indoor unit and its associated Y-branch fitting.

B. Heat Recovery Applications:

1. Hard tubing between the outdoor unit and branch selector box.

2. Soft-annealed tubing between the branch selector box and indoor unit.

C. Below Grade and Within Slabs:

1. Soft-annealed tubing for 2 inch and smaller without joints.

2. Install tubing in insulated PVC or HDPE protective conduit. Vent conduit to the outdoors.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside of piping before assembly.

3.03 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install piping to meet ASME B31.9 requirements.

C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

D. Do not install PVC or non-plenum rated HDPE piping used for sleeves or vent piping in return air plenums.

3.04 PIPING INSTALLATIONS

A. Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration" and the equipment manufacturer's installation requirements.

B. Coordinate routing and install piping and specialties in accordance with the VRF equipment manufacturer's installation instructions, including the angle and direction of manufacturer supplied fittings, bends before and after fittings, and line length limitations between fittings and total line length.

C. Arrange piping to return oil to the compressor. Do not use traps or double suction risers. Notify engineer of record and equipment manufacturer immediately if actual field conditions will result in effectively creating a trap in the piping system so an alternative solution may be provided.

D. Connect indoor units to the outdoor units with grouping as shown on the plans and piping configuration in compliance with the VRF manufacturer's shop drawings.

E. Verify actual circuiting, refrigerant line quantities, lengths, sizes, fitting types, and locations with the VRF manufacturer's shop drawings.

F. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Locate groups of pipes parallel to each other. Install valves and specialties in accessible locations to allow for servicing and inspection. Install piping with sufficient space above removable ceiling panels to allow for panel removal.

G. Install piping with adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

H. Insulate all refrigeration lines per Division 23 Section “HVAC Insulation.”

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

J. Slope refrigerant piping as recommended by the manufacturer’s installation instructions. Install piping as high as necessary to allow for the required slope and in coordination with other components.

K. Use fittings for all changes in direction and all branch connections for hard-drawn tubing.

L. Install piping free of sags and bends. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated. Install vertical piping tight to columns or walls.

M. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, unless indicated to be exposed to view.

N. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

O. Pipe Protection for Flammable Refrigerants: Protect refrigerant piping used for A2L and B2L refrigerants located in concealed locations where tubing is installed in studs, joists, rafters or similar member spaces and located less than 1.5 inches from the nearest edge of the member. Piping shall be continuously protected by protective shield plates having a minimum thickness of 0.0575 in (No. 16 gage) and shall cover the area of the tube and shall extend a minimum of 2.0 inches beyond the outside edge of the tube.

3.05 HANGERS AND SUPPORTS

A. Comply with the requirements of Division 23 Section “Hangers and Supports for HVAC Piping and Equipments."

1. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing. Provide plastic galvanic isolators for copper tubing where indicated.

B. Install the following pipe attachments:

1. Provide insulation saddles and protection shields as specified in Section “Hangers & Supports for HVAC Piping & Equipment”. Provide insulation inserts as specified in Section “HVAC Insulation”.

C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size (in)	Max. Span (ft)	Min. Rod Size (in)
Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
4	12	1/2
6	14	5/8

D. Support vertical runs at each floor. Support riser piping independently of connected horizontal piping.

E. Install a support within one foot of each change of direction.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

3.06 PIPE JOINT CONSTRUCTION

A. Piping Joints:

1. Provide brazed connections at all piping joints.

2. Provide brazed connections at outdoor unit connections. Mechanical flare fittings are not permitted except at the indoor equipment final connection.

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

2. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do no apply heat near the bulb of the expansion valve.

C. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.

D. Dissimilar metals such as copper and brass shall be joined using an appropriate flux with either BCuP-5 or Bag-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.

E. Continuously purge the pipe and fittings during brazing with an inert gas per manufacturer's recommendation (e.g., dry nitrogen) to prevent formation of scale. Maintain purge until the joint is cool to the touch.

F. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

G. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

3.07 VALVE AND PIPING SPECIALTIES INSTALLATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install shutoff valves at the outlet of each branch selector box, either factory or field-installed, and tagged with the zone number it serves. Reference Section 230553 "Identification for HVAC Piping and Equipment" for tagging requirements.

C. Tag piping and valves from branch selector boxes indicating indoor unit number and room served. Refer to section "Identification for HVAC Piping and Equipment" for tagging materials.

D. Install suction line filter assembly upstream of the condensing unit.

3.08 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow servicing and maintenance.

C. Anchor piping at connections to equipment to prevent movement caused by expansion and contraction from transferring to the equipment.

3.09 FIELD QUALITY CONTROL

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

B. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5. Provide test report summarizing the test procedures and results of the tests.

C. Leak test all refrigerant containing components of each system after installation. Pressurize with manufacturer recommended gas to manufacturer recommended pressure and hold for 24 hours minimum. Submit test report with date/time stamped photos of the pressure gauges at both the beginning and ending of a successful pressure test or documented observation by a third party.

D. Repair leaking joints using new materials, and retest for leaks.

E. Triple evacuate all refrigerant containing components of each system after installation according to the manufacturer's recommended procedures. Submit test report.

F. After positive pressure test with no leaks, vacuum dry the system to a minimum of 500 microns in compliance with the VRF manufacturer's installation instructions.

3.10 CHARGING AND CLEANING

A. Clean and inspect refrigerant piping systems in accordance with requirements of Division-23 Basic Piping Materials and Methods.

B. Charge system using the following procedure:

1. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
2. During evacuation, apply heat to pockets, elbows, and low spots in piping.
3. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
4. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
5. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

C. After charging, close the bypass isolation valve and open isolation valves around the bypass suction filter. Place all units in cooling mode. Use the manufacturer's maintenance tools and modes to partition the indoor unit connected capacity into thirds. For each partitioned zone, flow refrigerant through the bypass suction filter for 20 minutes in accordance to the manufacturer's instructions. Repeat for each partitioned zone. After each partitioned zone filtering is complete, open the bypass isolation valve and close the isolation valves around the bypass suction filter.

D. Provide additional refrigerant for replacement of any refrigerant lost during leak testing, repair, or charging.

3.11 STARTUP

A. Provide VRF factory trained representative for charging and system startup. Reference Division 23 Section "Variable Refrigerant Flow Split AC Systems" for requirements.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 1 section "Closeout Procedures."

D. Schedule training with Owner through the Architect, with at least 7 days advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.

B. Duct liner.

C. Duct sealants.

D. Duct hangers and supports.

E. Wire rope hanging system.

F. Manufactured ductwork and fittings.

G. Factory-fabricated grease exhaust ductwork.

1.02 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.

2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.04 SUBMITTALS

A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Duct Liner.

2. Sealing Materials.

3. Fire-Stopping Materials.

4. Duct Cleaning Products.

B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.

2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.

3. Fittings.

4. Reinforcing details and spacing.

5. Seam and joint construction details.

6. Penetrations through fire-rated and other partitions.

7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.

8. Locations of fire and fire/smoke dampers and associated duct access doors.

9. Locations of cleanout and access doors in grease exhaust ducts.

10. Location of manual balancing dampers.

11. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.

12. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:

1. Coordination with ceiling suspension members.

2. Spatial coordination with other systems installed in the same space with the duct systems.

3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.

4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

D. Leak test report for ducts specified to be leak tested in Part 3. Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

E. Leak Test certificate for all smoke control duct joints and fittings in compliance with the locally adopted IMC.

F. Leak Test certificate for all grease duct joints and fittings in compliance with the locally adopted IMC.

G. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.

H. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

I. Deferred Submittals: Submit signed and sealed drawings that indicate the design and installation requirements of pre-engineered roof supports can withstand the design criteria listed in this specification. Include installation requirements for anchoring to the roof structure. The Engineer is not responsible and will not provide the seal and signature. Deliver submittal to the local AHJ for approval prior to installation of the contractor provided, pre-engineered roof supports.

J. Duct Cleaning Plan: Submit written work plan including the following information:

1. Scope of work identifying components that will be cleaned.
2. Identify specific environmental engineering controls required for area of work.
3. Detail the cleaning work means and methods.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

D. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

E. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

2. NFPA 90B, “Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

F. Sheet Metal and Air Conditioning Contractors’ National Association, Inc. (SMACNA): Provide ductwork systems in conformance with “HVAC Duct Construction Standards – Metal and Flexible,” latest edition.

G. Underwriter’s Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.

H. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

I. Deferred Submittals: Signed and sealed by a professional engineer or National Institute for Certification in Engineering Technologies (NICET) stamp and signature. The professional engineer shall be licensed in the same state in which the project is located.

1.06 PROTECTION AND REPLACEMENT

A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.

B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

1.07 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS

2.01 DUCT ASSEMBLIES

A. Ducts: Galvanized steel, unless otherwise indicated. Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.

B. Supply Air Ducts (constant volume or single zone VAV systems): 3 inches w.g pressure class, galvanized steel.

C. Primary Supply Air Ducts (upstream of terminal boxes in multizone VAV systems): 4 inches water gauge.

D. Secondary Supply Air Ducts (downstream of terminal boxes in multizone VAV systems): 2 inches water gauge

E. Return and Relief: 2 inch w.g. pressure class, galvanized steel.

F. General Exhaust: 2 inch w.g. pressure class, galvanized steel.

G. Dishwasher Hood Exhaust Ducts: 2 inch w.g. pressure class.

1. Type 304, stainless steel, minimum 18 gauge, with finish to match kitchen equipment and range hood. Provide continuously welded seams on top or sides of duct and flanged joints with watertight EPDM gaskets.

2. Aluminum, with longitudinal seams and laps arranged on top of duct. Seal joints with silicone sealant to provide watertight joint.

H. Type I (Grease) Hood Exhaust Ducts: 2] inch w.g. pressure class, comply with NFPA 96.

1. Concealed: Carbon-steel sheet, minimum 16 gauge.

2. Exposed:

a) Interior to the Building: Type 304, stainless steel, minimum 18 gauge, with finish to match kitchen equipment and range hood.

b) Exterior to the Building:

1) Type 304, stainless steel, minimum 18 gauge.

2) Carbon-steel sheet, minimum 16 gauge, coated with an exterior rated, high temperature corrosion resistant paint.

3. Weld and flange seams and joints.

4. At Contractor's option, a UL listed concentric ductwork package may be used in lieu of the welded carbon or stainless steel duct for connecting hood to exhaust fan. Provide manufacturers UL listing number and verification certificate as a part of the shop drawing submittal. Install duct package in strict conformance with manufacturer's instructions and recommendations.

I. Dryer Vent Ducts: 2 inch w.g. pressure class, rigid, smooth wall, aluminum or stainless steel duct, minimum 26 gauge.

J. Outside Air Intake: 2 inch w.g. pressure class, galvanized steel.

K. Transfer Air and Sound Boots: 1/2 inch wg pressure class, galvanized steel.

L. Duct Liner Application: Provide duct liner on the following air ducts and where specified on the drawings.

1. Supply Ductwork:

a) Exposed rectangular ductwork.

b) Exposed round ductwork.

c) First 15 feet of ductwork downstream of equipment outlets including exterior ductwork. Refer to Section “HVAC Insulation” for additional insulation requirements for exterior ductwork.

2. Return Ductwork.

a) Exposed rectangular ductwork.

b) Exposed round ductwork.

c) First 15 feet of ductwork upstream of equipment outlets including exterior ductwork. Refer to Section “HVAC Insulation” for additional insulation requirements for exterior ductwork.

3. Transfer Ductwork.

2.02 MATERIALS

A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.

B. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating.. Provide mill phosphatized or galvanized finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.

C. Carbon Steel for Ducts: ASTM A1008/A1008M, Designation CS (commercial steel), cold-rolled, with oiled, exposed matte finish.

D. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength, with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.

E. Stainless Steel for Ducts: ASTM A 480, Type 316, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No. 1 finish for concealed ducts.

F. Duct Liner

1. General:

a) Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.

b) Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 or UL 723.

c) Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.

2. Fiberglass: ASTM C1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.

a) Rectangular fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.

1) Thickness and Density:

(a) 1 inch, 1-1/2 pounds per cubic foot.

b) Round fiberglass duct liner shall be Certainteed ToughGard UltraRound, JohnsManville Spiracoustic Plus, Owens Corning QuietZone Spiral, or approved equal.

1) Thickness and Density:

(a) 1 inch, 4 pound per cubic foot.

c) Thermal Performance: Meet minimum "K-Factor" equal to 0.28 (Btu·in/h·sq ft·F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.

d) Noise Reduction Coefficient (NRC): Meet the following minimum NRC in accordance with ASTM C423 Type A Mounting:

1) 1 Inch Thick: NRC 0.65.

e) Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 50% solid content, water-based, non-oxidizing and have a service temperature of –20 to 200 F. Water-based adhesive shall be one of the following:

1) Design Polymerics DP 2502.

2) Duro Dyne WIT.

3) Foster 85-60.

4) Childers CP-127.

5) Johns Manville SuperSeal.

6) Hardcast Coil-Tack.

7) United McGill Uni-Tack.

f) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.

1) Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.

2) Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

G. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.

2. Sealants used on metal duct systems shall comply with VOC limits under VOC table classifications as “other” per SCAQMD Rule #1168.

3. Surface Burning Characteristics: Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.

4. For Use with Flexible Ducts: UL labeled.

5. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics. Duct tape shall not be used as a sealant on any ducts.

6. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.

7. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

8. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 65 percent solids. Approved products: Design Polymerics DP-1090, , Duro Dyne SGD, Fosters 32-14, or approved equal.

9. Water-Based Joint and Seam Sealant: Non-Fibrated, UL 181 listed, rated to minimum SMACNA Pressure Class of ±10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved

products: Childers CP-146, Design Polymerics DP 1010, Ductmate Proseal, Duro Dyne Duroseal EDS-RS, Fosters 32-18, Hardcast Iron-Grip 601, Red Devil D-Seal and United McGill United Duct Seal WB.

10. Water-Based Joint and Seam Sealant: Fiber reinforced, UL 181 listed, rated to minimum SMACNA Pressure Class of ±10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymerics DP 1030, Ductmate Fiberseal, Duro Dyne Duroseal EDS-RF, Fosters 32-17, Hardcast CCWI-181, Red Devil F-Seal 181 or United McGill Uni-Mastic.

11. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

12. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of –25 to 180 F. Approved Products: Design Polymerics DP 1040, Ductmate 440, and Hardcast 1104.

H. Fire Stopping

1. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

2. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

3. Products: Subject to compliance with requirements, provide one of the following:

   a) "3M Fire Stop Foam"; 3M Corp.

   b) "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.

   c) 3M Fire Stop Sealant"; 3M Corp.

   d) "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.

   e) "Fyre Putty"; Standard Oil Engineered Materials Co.

   f) “FS-ONE”, Hilti, Inc.

I. Hangers and Supports

1. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
2. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
    a) Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
    b) Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
    c) Concrete Screw Type Anchors: Complying with ICC-ES AC193.
    d) Masonry Screw Type Anchors: Complying with ICC-ES AC106.
    e) Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
3. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
4. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
    a) Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
    b) Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.
5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
6. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
    a) Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
    b) For stainless steel ducts, provide stainless steel support materials.
    c) For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.
7. Wire Rope Hanging Systems:
    a) General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
    b) Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
    c) Wire Rope: Zinc coated or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

d) Cable Lock: Cast zinc housing with steel spring with wedge grip, selected to meet the vertical load applied to the hanging system and wire thread. Do not exceed the working load limit.

e) Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

f) Seismic Applications: Wire rope hanger systems used for seismic supports shall be seismically tested according to ICC code guidelines EG284 with UL and SMACNA seismic approvals. Reference Division 23 Section "Seismic Controls for Mechanical Systems" for additional requirements.

g) Manufacturers:

1) ASC Engineered Solutions.

2) Ductmate Industries, Inc; Cable Shark Cable Hanging System.

3) Duro Dyne.

4) Gripple.

J. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

K. Tie Rods: Same material as the duct, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 DUCTWORK FABRICATION

A. Fabricate and support duct in accordance with latest edition of SMACNA (DCS).

B. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.

2. Fabricate ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.

E. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.

F. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.

G. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

H. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer’s approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section “Ductwork Accessories” for turning vane construction and mounting.

I. Provide full radius elbows for ductwork installed in noise critical spaces. Refer to Section “Basic Mechanical Materials and Methods” for noise critical spaces. Where space does not permit the installation of radius elbows, provide mitered elbows with sound attenuating, acoustical turning vanes. Refer to Section “Ductwork Accessories” for acoustical turning vanes.

J. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

K. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

L. Round and Flat Oval Duct Fabrication

1. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.

a) Fabricate round and flat oval ductwork of minimum 26 gauge sheet metal.

M. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.

N. Round and Flat Oval Fittings Fabrication

1. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.

2. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

3. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:

a) Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.

1) Elbows in Round Duct: Provide full radius elbows.

2) Elbows in Flat Oval Duct: Provide full radius elbows. Where space limits the installation of full radius elbows, short radius elbows with a minimum of two continuous splitter vanes shall be installed. Vane length shall be the entire length of the bend or 36 inches whichever is greater.

3) The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

4) Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section “Basic Mechanical Materials and Methods” for noise critical spaces.

b) Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.

1) Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with

SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.

2) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

(a) 3 to 26 inches: 24 gauge.

(b) 27 to 36 inches: 22 gauge.

(c) 37 to 50 inches: 20 gauge.

(d) 52 to 60 inches: 18 gauge.

(e) 62 to 84 inches: 16 gauge.

3) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

(a) 3 to 14 inches: 24 gauge.

(b) 15 to 26 inches: 22 gauge.

(c) 27 to 50 inches: 20 gauge.

(d) 52 to 60 inches: 18 gauge.

(e) 62 to 84 inches: 16 gauge.

4) Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.

5) 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.

c) Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

d) Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

e) Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

f) Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.

g) Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.

h) Flat Oval Elbows Gauges: Same as longitudinal seam flat oval duct.

i) Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.

O. Shop Application of Liner in Rectangular Ducts

1. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

2. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

3. Butt transverse joints without gaps and coat joint with adhesive.

4. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

a) Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.

5. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

6. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

a) Fan discharge.

b) Intervals of lined duct preceding unlined duct.

c) Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.

7. Secure insulation liner with perforated sheet metal liner of the same gauge specified for the duct, secured to ducts with mechanical fasteners that maintain metal liner distance from duct without compressing insulation. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent.

8. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

A. General: At the Contractor’s option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer. The oval duct system shall be sealed with duct sealer as specified.

1. Ducts shall be calibrated to manufacturer's published dimensional tolerance standard.
2. All duct 14" diameter and larger shall be corrugated for added strength and rigidity.
3. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
4. Ducts shall be constructed using spiral lock seam sheet metal construction.
5. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

B. Duct Construction

1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10” water gauge pressure with minimum wall thickness as shown in the following tables.
2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.
3. Ducts shall be constructed using spiral lock seam sheet metal construction.

Single Wall Round Duct:

Diameter (in)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)
3 to 14	28	24
15 to 24	26	24
26 to 42	24	22
42 to 60	22	20

C. Fittings:

1. All fitting ends for round duct and transitions and divided flow fittings smaller than 24” diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.

2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.

3. All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.

4. All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.

5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be minimum 1.0 times the elbow diameter.

6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.

7. All volume dampers shall be Linx Safe type DRU, DSU or DTU or equal by an acceptable manufacturer. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:

   a) Locking quadrant with blade position indicator.

   b) 2" sheet metal insulation stand-off.

   c) Integral shaft/blade assembly.

   d) Shaft mounted, load bearing bushings.

   e) Gasketed shaft penetrations to minimize leakage.

D. Manufacturers:

1. Hercules Industries.

2. Hranec Corporation.

3. Lewis & Lambert.

4. Linx Industries, Inc.

5. Semco.

2.05 CONCENTRIC DUCT FOR GREASE EXHAUST

A. General: At Contractors option, in lieu of welded carbon or stainless steel grease exhaust duct, a pre-fabricated concentric duct package may be used subject to local code authority approval. Provide fire rating and clearance to combustibles listing as applicable for the installation.

B. Code Compliance: Material and installation shall comply with UL 1978, UL 2221, ASTM E814, and NFPA 96. [Zero clearance applications shall also comply with BOCA ER 96-37 or ICBO ER 5301 Zero Clearance to Combustibles Report].

C. Product Description:

1. Grease duct shall be factory prefabricated, double wall type, listed for venting of grease laden air from Type 1 kitchen hoods serving commercial cooking appliances.
2. Material and installation shall be rated for continuous operation at 500 F and intermittent operation at 2000 F.
3. All grease duct system components shall be by manufacturer to maintain approval agency ratings including supports, guides, fittings, cleanouts, and expansion joints.
4. Grease duct system shall meet ASTM E119 2-hour fire resistance rating and 3-hour fire engulfment rating and ASTM E814 3-hour Fire Stop Test.
5. Grease duct system shall be SBCCI tested as an alternate to a 2-hour fire rated shaft and SBCCI classified as a 2-hour fire rated enclosure.
6. The grease duct system shall be constructed of inner and outer walls with ceramic fiber insulation between the walls.
7. The inner wall shall be constructed of stainless steel, minimum 0.035 inch thickness.
8. The inner wall shall be constructed of minimum 18 gauge stainless steel and shall be all welded construction.
9. The outer wall shall be constructed of aluminized steel or Type 430, Type 304, or 316 stainless steel, minimum 0.024 inch thickness. Provide aluminized steel if duct is exposed and will be field painted.
10. The insulation shall be minimum 2 inch thickness soluble ceramic fiber.
11. The grease duct assembly shall be rated for 1-inch clearance to combustibles up to 18 inch diameter, and 2-inch clearance to combustibles up to 32 inch diameter.
12. The grease duct assembly shall be rated for zero clearance to combustibles.

D. Manufacturers:

1. Ampco.
2. CaptiveAire
3. DuraVent Commercial.
4. Enervex.
5. Metal-Fab G.
6. Schebler Chimney Systems.
7. Security Chimneys.
8. Selkirk ZeroClear.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products in accordance with manufacturer's instructions.

C. Install ducts with the fewest possible joints.

D. Seal duct joints with the appropriate sealing material.

E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

J. Install insulated ducts with 1-inch clearance outside of insulation.

K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

M. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.

N. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

O. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

P. Acoustical Barrier Penetrations: Where a duct passes through a wall, ceiling or floor slab of a noise critical space, provide a clear annular space of 1-inch between the duct and the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The Contractor shall check the clearance and, if clearance is acceptable, shall install the duct and pack the voids full depth with mineral fiber batt insulation. Contractor shall caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material. Where there is insufficient clearance space, Contractor shall place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

Q. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.

R. Duct Liner Installation

1. Fiberglass Duct Liner:

a) Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.

S. Kitchen Hood Exhaust

1. Provide for thermal expansion of ductwork through 2,000°F temperature range.

2. Install without dips or traps that may collect residues, except where traps have continuous or automatic residue removal.

3. Horizontal Ducts:

a) Provide at least one opening that is minimum size of 20 inches by 20 inches for personnel entry. Where an opening of this size is not possible, provide access openings at each change in direction and at 12-foot intervals. Locate openings on sides of duct 1-1/2 inches minimum from bottom, and fit with grease-tight covers of same material as duct. Support systems for ducts 24 inch and larger in any dimension shall be designed for the weight of the duct plus 800 pounds at any point in the duct system.

b) Slope horizontal ductwork serving a Type I hood back toward the hood or local grease reservoir a minimum of 1/4 inch per foot. Horizontal ducts that exceed 75 feet in length shall be sloped not less than 1 inch per foot.

4. Vertical Ducts:

a) For ducts larger than 24 inches by 24 inches, provide a 20 inch by 20 inch access opening for personnel entry at the top of the vertical riser.

b) For ducts smaller than 24 inches by 24 inches, provide an access opening at each floor level in a location that is accessible and not higher than 12 feet above finished floor.

c) Supports for ducts large enough for personnel entry shall be designed for the weight of the duct plus 800 lbs at any point in the duct system.

5. Provide transition at connection to fan with opening size equal to or greater than the venturi opening of the fan inlet. Provide gasket at flanged connection to fan rated for 1500 F and grease applications.

6. Do not penetrate fire-rated assemblies without providing shaft, field-applied or factory-built enclosure.

T. Dishwasher Exhaust Duct Installations

1. Install dishwasher exhaust duct systems in accordance with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 10-2.

2. Slope horizontal ductwork back towards dishwasher hood a minimum of 1/4” per foot. Where distance does not allow continuous slope in ductwork, provide low point drains with the following:

3. Drip leg with 3/4 inch plenum rated drain tubing routed to discharge at code approved location.

4. Pigtail trap or U-trap sized for system pressure.

U. Dryer Vent Ducts

1. Install dryer vent exhaust ducts in accordance with dryer manufacturer’s installation instructions.

2. Install dryer vent ducts without kinks. Install duct joints with overlap, with the male end extending in the direction of airflow. Make connections with metal clamps adjustable using phillips/hex head screws. Do not penetrate duct with sheet metal screws.

3. Connect individual dryer vents into main header using lateral, 45 degree tees to minimize pressure drop.

4. Install vertical risers with a means for cleanout.

5. Install a backdraft damper at termination of the dryer vent duct.

V. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

W. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

X. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

Y. Seam and Joint Sealing

1. General: Seal duct seams and joints as follows:

a) All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.

b) Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized. Transfer air ducts and sound boots do not need to be sealed.

2. Seal externally insulated ducts prior to insulation installation.

3. Ductwork installed exterior to the building without weather-proof jacket or cladding shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

a) Lined Ductwork: Where exterior ductwork is specified on the drawings to be provided with interior lining for thermal or sound performance requirements, seal the longitudinal and transverse joints with sealant rated for exterior exposure.

4. Aerosolized Duct Sealing:

a) Application must be performed by a manufacturer approved service provider and the procedure shall be done as per manufacturer’s recommendations.

b) Duct Preparation:

1) Inspect air distribution system for major leakage and repair major leakage greater than ½ inch externally using mastic and tapes per SMACNA standards.

2) Inspect air distribution system for significant accumulation of dust, dirt and debris and remove all debris and significant dust and dirt by duct cleaning method.

3) Temporarily remove or protect from aerosol particles building instrumentation and control devices, humidifier dispersion tubes, and fire and smoke sensors. Temporarily isolate air moving equipment and block off air inlets and outlets.

c) Duct Sealing:

1) Seal air distribution system from the inside using automated aerosolized sealant injection.

2) Repair all injection and test holes in existing ductwork sealed tight as per SMACNA standards.

Z. Hanging and Supporting

1. Install rigid round, rectangular, and flat oval metal duct with support systems per SMACNA standards.

2. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.

    a) Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.

3. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

4. Support vertical ducts at a maximum interval of 16 feet and at each floor.

5. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.

6. Install concrete insert prior to placing concrete.

7. Install powder actuated concrete fasteners after concrete is placed and completely cured.

8. Provide double nuts and lock washers on threaded rod supports.

9. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

10. Installation of Pre-Engineered Roof Duct Supports:

    a) Install pre-engineered roof duct supports to rest on the roofing membrane without attachment to the roof structure or penetration through the roofing assembly.

    b) Install pre-engineered roof duct supports anchored to the roof structure.

        1) Install supports to meet the specified design criteria.

            (a) Building Design Risk Category: [II][III or IV].

            (b) Design Wind Speed: [XXX] mph.

        2) Coordinate with the pre-engineered roof duct support manufacturer to anchor the duct supports directly to the roof structure in accordance with the manufacturer's installation instructions or provide intermediate duct supports engineered to meet the design criteria.

3) Submit design and installation requirements as a Deferred Submittal.

4) Pre-Engineered Duct Support Rails: Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope. Install supports to maintain continuous insulation on roof.

11. Refer to Section “Seismic Controls for Mechanical” for seismic bracing requirements.

AA. Penetrations

1. Fire Barrier Penetrations: Where ducts pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

2. Exterior Wall Penetrations: Seal duct penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

3. Underground Exterior Wall Penetrations: Seal duct penetrations through underground exterior walls with sleeves, packing, and sealant. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

4. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Piping Materials and Methods” for special sealers and materials.

BB. Connections

1. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."

2. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards”.

3. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards". Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."

4. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards”.

3.02 FIELD QUALITY CONTROL

A. The Owner will contract with an independent testing agency to perform, record, and report leakage tests.

B. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

C. General Duct Systems: Perform leakage tests on the duct systems listed below in accordance with ASHRAE and SMACNA standards.

1. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

2. Conduct tests at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure. Give 7 days' advanced notice for testing. Submit a letter report to the Owner and Engineer summarizing the test procedures followed, systems tested and the results of the leakage tests.

3. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.

4. Maximum Allowable Leakage: As described in ASHRAE 2005 Handbook, "Fundamentals" Volume, Chapter 35, Table 9 and Figure 13. Comply with requirements for leakage classification 3 for round and flat oval ducts, leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gauge (both positive and negative pressures), and leakage classification 6 for pressure classifications greater than 2 inches water gauge and less than and equal to 10 inches water gauge.

5. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

6. Leakage Test: Perform volumetric measurements and adjust air systems as described in Testing, Adjusting and Balancing chapter of ASHRAE "HVAC Applications" Volume, Duct Design chapter of ASHRAE "Fundamentals" Volume, andDivision 23 Section "Testing, Adjusting and Balancing for HVAC."

D. Ductwork with Pressure Rating > 3" W.C.: Ducts and plenums shall be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual to prove they meet leakage classification less than or equal to 6. Submit test reports to the Engineer of Record demonstrating that at least 25 percent of the installed duct area has been tested and pass this test.

E. Grease Duct Leakage Test: Test all portions of grease duct systems including joints and connections to hoods for leakage prior to use or concealment of any portion of the grease duct system. Concealed ducts include any ducts that are installed in shafts or that are covered by coatings or wraps.

1. Perform leakage test using light test in accordance with Chapter 5, Section 506 of the locally adopted IMC or other equivalent test method as

approved by the local code official to verify that all joints are liquid tight. Perform tests in the presence of the local code official. Repair and retest any joints found defective until satisfactory results are obtained. Submit a copy of the grease duct leakage test report to the Architect and Engineer complete with the approval signature of the local code official.

2. Perfrom leakage test using a smoke pressure test using one or more smoke machines to fill the duct with a thick penetrating smoke. Maintain a positive pressure not less than 2 inches w.g. for sufficient time to permit inspection of the grease duct being tested. Perform tests in the presence of the local code official. Repair and retest any joints found defective until satisfactory results are obtained. Submit a copy of the grease duct leakage test report to the Architect and Engineer complete with the approval signature of the local code official.

3.03 ADJUSTING, STARTUP AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "Testing, Adjusting and Balancing for HVAC" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum duct systems prior to final acceptance to remove dust and debris.

C. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.

D. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Turning Vanes

B. Combination fire and smoke dampers.

C. Duct access doors.

D. Duct hardware.

E. Duct test holes.

F. Fire dampers.

G. Flexible duct connectors.

H. Smoke detectors

I. Volume control dampers.

J. Duct opening closure film.

K. Cable operated damper systems.

L. Fire rated duct wrap.

M. Flexible ductwork.

N. Flexible elbow assembly.

O. Duct silencers.

1.02 SUBMITTALS

A. Product Data: Provide for each type of ductwork accessory the following:

1. Electrical characteristics
2. Connection requirements.
3. Dimensions.
4. Capacities.
5. Pressure drops.
6. Leakage rates.
7. Materials of construction.

B. Shop Drawings: Indicate for shop fabricated assemblies the following:

1. Interfacing requirements with ductwork.
2. Method of fastening or support.
3. Methods of assembly of components.

C. Performance Data: Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.

D. Project Record Drawings: Record actual locations of access doors and test holes.

E. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data and show drawings in maintenance manual.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. SMACNA Compliance: Comply with applicable portions of SMACNA (DCS) “HVAC Duct Construction Standards Metal and Flexible”.

C. UL Compliance:

1. Fire Dampers: Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 Standard for Fire Dampers.
2. Smoke Dampers: Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S Standard for Smoke Dampers.
3. Flexible Ductwork: Construct flexible ductwork in compliance with UL Standard 181 Factory-Made Air Ducts and Connections..
4. Duct Tape: Label in accordance with UL Standard 181B and marked 181B-FX.
5. Duct Clamps: Label in accordance with UL Standard 181B and marked 181B-C.
6. Fire Rated Duct Wrap: Meet the fire protection requirements defined by UL Standard 1479 Fire Tests of Through-Penetration Firestops.
7. Grease Exhaust Duct Wrap: Meet the fire protection requirements defined by UL Standard 1479 Fire Tests of Through-Penetration Firestops.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

E. NFPA Compliance

1. Comply with applicable provisions of NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems and NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems pertaining to installation of ductwork accessories.

2. Comply with NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for fire-rated grease exhaust ducts.

F. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials (NFPA 255) method.

1. Duct silencers shall be tested for performance in accordance with ASTM E477 "Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers."

2. Grease exhaust duct wrap shall be tested for performance in accordance with ASTM E 2336 "Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems" and ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".

3. Fire rated duct wrap shall be tested in accordance with ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect duckwork accessories during shipping and storage from dirt, debris and moisture damage.

B. Protect dampers from damage to operating linkages and blades.

1.05 SPARE PARTS

A. Extra Fusible Links: One link for every 10 installed of each type, size, and temperature range. Obtain receipt.

PART 2 - PRODUCTS

2.01 TURNING VANES

A. Manufacturer:

1. Aero Dyne Co.

2. Anemostat Products Div.; Dynamics Corp. of America.

3. Ductmate Industries

4. Duro Dyne corp.

5. Elgen Manufacturing Co., Inc.

6. Hart & Cooley Mfg. Co.
7. Register & Grille Mfg. Co., Inc.
8. Sheet Metal Connectors, Inc.

B. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed.

1. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration.
2. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened.
3. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

C. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section "Common Work Results for HVAC" for noise critical spaces.

2.02 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Cesco Products
3. Greenheck
4. Louvers & Dampers, Inc.
5. Nailor Industries, Inc.
6. Pottorff.
7. Prefco
8. Ruskin Mfg. Co.

B. General: Provide combination fire and smoke dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire and/or smoke ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire and smoke damper and fusible link as required. Provide sleeves of length as required to meet the installed location. Damper assemblies shall be provided as a single unit from the manufacturer.

C. Fabricate dampers in accordance with NFPA 90A, UL 555 (current edition) classified fire damper of rating required for location installed, UL 555S (current

edition) classified smoke damper for leakage class II and rated for dual directional airflow.

D. Fire/smoke dampers shall be rated for closure in ducts up to minimum velocity of 2,000 fpm and static pressure of 4" w.g.

E. Multiple Blade Dampers:

1. Frame: Mininum 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.
2. Blades: Minimum 22-ga thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2.000 fpm.,
3. Bearings: Self-lubricating, turning in extruded hole in the frame.
4. Linkage: Plated steel axles, linkage concealed in frame, 1/2” actuator shaft
5. Seals: Flexible, stainless steel jamb seals, silicone rubber blade seals with galvanized steel mechanical locked in to the blade edge, and stainless steel spring loaded leakage seals in sides of casing. Provide stainless steel spring loaded leakage sealsin sides of casing, and the following additional features:
    a) Open-closed indication switch.
    b) Temperature Limited Override.
    c) Test Switch.
    d) Smoke Detector.

F. Operators

1. UL listed and labelled.
2. Spring return open/fail closed operation.
3. Two-position or modulating as required for the installation.
4. Electric type suitable for 120 volts, single phase, 60 Hz.
5. Factory installed on dampers.
6. All operators shall open in between 7 and 15 seconds and close in between 7 and 15 seconds after alarm or smoke detection has occurred.
7. Rated for a minimum of 20,000 cycles of operation.
8. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.

G. Electro Thermal Link: Provide resettable temperature device rated at 160 and 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide 36" long wire leads for connecting smoke link to smoke detector.

H. Smoke Activation:

1. Provide 36" long wire leads for connecting smoke link to smoke detector,
2. Provide terminal block for connection to the building fire alarm system.

I. Accessories:

1. Open-closed indication switch.
2. Temperature Limited Override.
3. Test Switch.
4. Smoke Detector.
5. Integral end switch.

2.03 DUCT ACCESS DOORS

A. Manufacturers:

1. Air Balance Inc.
2. Ductmate Industries.
3. Duro Dyne Corp
4. Greenheck.
5. Register & Grille Mfg. Co, Inc.
6. Ruskin Mfg. Co.
7. Ventfabrics, Inc
8. Vent Products
9. Zurn Industries, Inc. Air Systems Div

B. Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10” by 10” and maximum size of 24” by 24”. Fabricate in accordance with SMACNA (DCS) and as indicated. Label access doors for fire and smoke dampers as specified in Part 3.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. Construct of same or greater gauge as ductwork served. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct.

1. 12 inches Square or less: Provide one side hinged, other side with one handle-type latch. Provide removable section of duct where duct size is too small for a 10” by 10” access door.
2. Larger than 12 inches Square: Provide two hinges and two handle-type latches.

2.04 DUCT HARDWARE

A. Manufacturers:

1. Ductmate Industries.
2. Elgen Manufacturing, Inc
3. Ventfabrics, Inc.
4. Young Regulator Co.

B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated.

1. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
2. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plats for externally insulated ductwork.

2.05 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Cesco Products.
3. Greenheck
4. Louvers & Dampers, Inc.
5. Nailor Industries, Inc.
6. Pottorff
7. Prefco Products, Inc.
8. Ruskin Mfg. Co.

B. General: Provide fire dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire damper and fusible link as required. Provide sleeves of length as required to meet the installed location.

C. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

D. Fire dampers shall be dynamic-rated for closure under pressure.

E. Provide positive lock in closed position.

F. Horizontal Dampers: Minimum 22 gage, 0.0299 inch galvanized steel frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket. Construct casings frames of 20-gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.

G. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height. Construct frames of 20-gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.

H. Multiple Blade Dampers: Minimum 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. Construct frames of 20-ga stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.

I. Fusible Links: UL 33, separate at 160 to 165 degrees F unless otherwise indicated.

J. Accessories:

1. Open-closed indication switch.

2.06 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:

1. Carlisle HVAC Products.
2. Ductmate Industries.
3. Duro Dyne Corp.
4. Elgen Manufacturing Co., Inc.
5. Ventfabrics, Inc

B. Fabricate in accordance with SMACNA (DCS) and as indicated. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

C. Flexible Duct Connections: Fabric crimped into metal edging strip. Provide metal compatible with connected ducts. Factory fabricated. Flame retardant or noncombustible fabrics compliant with NFPA 701.

1. Indoor Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric compliant with NFPA 90A.

a) Minimum density 26 oz per sq. Yd.

b) Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

c) Service Temperature: Minus 40 to plus 200 deg F.

2. Outdoor Fabric: UL listed fire-retardant woven glass fiber fabric coated with weatherproof, synthetic rubber resistant to UV rays and ozone compliant with NFPA 90A.

a) Minimum density 24 oz per sq. yd.

b) Minimum tensile strength: 225 lbf/inch in the warp and 300 lbf/inch in the filling.

c) Service Temperature: Minus 40 to plus 250 deg F.

3. Metal: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24-gauge galvanized steel or 0.032-inch thick aluminum.

D. Maximum Installed Length: 14 inch.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

2.07 SMOKE DETECTORS

A. Manufacturers:

1. Fike.
2. Gamewell-FCI.
3. Kidde/Edwards
4. Notifier.
5. SimplexGrinnell.
6. Siemens-Cerberus Division.
7. Silent Knight.

B. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.

1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.

5. Contacts: Include low voltage supervisory and alarm contacts.

6. Provide remote alarm LEDs and remote test stations as shown on the plans.

7. Weatherproof Duct Housing Enclosure: NEMA EN 10250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

2.08 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Arrow United Industries
3. Cesco Products
4. Greenheck
5. Louvers & Dampers, Inc.
6. Nailor Industries, Inc.
7. Pottorff
8. Rossi Air Flow
9. Ruskin Mfg. Co.
10. TAMCO
11. Vent Products

B. Fabricate in accordance with SMACNA (DCS) and as indicated. Construct using galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.

C. Single Blade Dampers:

1. Fabricate for duct sizes up to 12 x 36 inch
2. Blade: 20 gauge, 0.04 inch, minimum.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

1. Blade: 18 gauge, 0.0478 inch, minimum.

E. Bearings: Corrosion resistant, molded synthetic.

F. Axles: Positively lock into the damper blade.

G. Blade Seals: Where used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.

H. Quadrants:

1. Provide locking, indicating quadrant regulators
2. On insulated ducts, provide extended shafts and mount regulator on stand-off brackets, bases, or adapters.
3. Where rod lengths exceed 48 inches provide regulator at both ends.

2.09 DUCT OPENING CLOSURE FILM

A. Mold-resistant, self-adhesive film to keep debris out of ducts during construction.

B. Thickness: 2 mils.

C. High tack water based adhesive.

D. UV stable.

E. Elongation Before Break: 325 percent, minimum.

2.10 CABLE OPERATED DAMPER SYSTEMS:

A. Manufacturers:

1. DuroDyne, DuroZone.
2. Metropolitan Air Technology, Inc.; (Reference model number for round damper is RT-250 and for rectangular damper is RT200).
3. Young Regulator Co. (Reference model number is 270).

B. General: Where access to dampers through a hard ceiling is required, provide a concealed, remote cable-operated, butterfly-type volume damper assembly with external worm gear operator.

C. Damper assembly shall include duct casing with rolled bead stiffeners, reinforced blade, self-lubricating bearing, and remote operator mounting plate.

D. Adjustable through the diffuser face or frame with standard 1/4” nutdriver or flat screwdriver.

E. Cable assembly shall attach to damper as single piece with no linkage adjustment required.

F. Positive, direct, two-way damper control with no sleeves, springs, or screw adjustments to come loose after installation.

G. Cable length as required to span the distance from the damper to the remote operator location.

H. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

2.11 FIRE RATED DUCT WRAP:

A. Manufacturers:

1. 3M.
2. Pyroscat
3. Thermal Ceramics
4. Unifrax Corporation

B. Grease Exhaust Duct:

1. Reference manufacturer and model number is Unifrax FyreWrap Elite 1.5.
2. Minimum two-hour rated duct wrap insulation for Type I hood grease exhaust duct applications.
3. Two layers of 1 1/2-inch thick wrap.
4. Density: Minimum 6 lb. per cubic foot.
5. Zero clearance to combustibles.
6. Flexible wrap enclosure rated for minimum 2000 F.
7. Material: Non-mineral wool, passive, low bio-persistent fiber totally encapsulated with aluminum foil reinforced with scrim. UL-listed in accordance with ASTM E2336.
8. Attachment:
   a) Ducts smaller than 24” by 24”: stainless steel bands at insulation seams and on maximum 12-inch centers to hold the outer layer of the blanket enclosure in place.
   b) Ducts larger than 24” by 24”: pins to hold the outer layer in place.
9. Insulation shall be tested for intended use in accordance with all applicable codes and shall be approved by the local code official.
10. Provide factory-built access doors by same manufacturer as fabricated for use specifically with the insulation system.

C. Dryer Vent Exhaust Ducts in Plenums:

1. Reference manufacturer and model number is Unifrax FyreWrap DPS.
2. Provide one-hour rated duct wrap insulation specifically designed to separate dryer vent exhaust ducts from an air plenum by preventing flame propagation and smoke development in the plenum area.
3. This system may be used as an alternative to a gypsum enclosure where allowed by the AHJ.
4. 1 1/2-inch thick wrap.

5. Density: Minimum 6 lb. per cubic foot.
6. Zero clearance to combustibles.
7. Flexible wrap enclosure rated for minimum 2000 F.
8. Material: Non-mineral wool, passive, low bio-persistent fiber totally encapsulated with aluminum foil reinforced with scrim. Fire-rated duct wrap material and installation shall be UL Listed in accordance withISO 6944-1 ISO 6944 and UL 1479, and as acceptable to the Authority Having Jurisdiction.

D. General for HVAC Ducts:

1. Reference manufacturer and model number is Unifrax FyreWrap Elite 1.5.
2. Provide duct wrap insulation for HVAC ducts required to be in rated enclosure construction where dampers are restricted.
3. One, two or three hour-rating as required for the installation.
4. 1 1/2-inch thick wrap.
5. Density: Minimum 6 lb. per cubic foot.
6. Zero clearance to combustibles.
7. Flexible wrap enclosure rated for minimum 2000 F.
8. Applied in one or more layers to achieve the hourly rating requirement.
9. Material: Non-mineral wool, passive, low bio-persistent fiber totally encapsulated on all sides with aluminum foil reinforced with scrim. UL Listed in accordance with ISO 6944-1 and UL 1479, and as acceptable to the Authority Having Jurisdiction.

E. Access Doors:

1. Manufacturer and/or model number:
   a) Ductmate Ultimate.
   b) FlameGard.
   c) Thermal Ceramics FastDoor XL.
   d) Or Equal
2. Duct access door to be tested and listed in accordance with UL 1978.
3. Gaskets: liquid tight and minimum 1500F rated.
4. Duct access to be provided with 2-hour and zero clearance insulation cover tested and UL Listed per ASTM E2336 by same manufacturer and as fabricated for use specifically with the insulation system.

2.12 FLEXIBLE DUCTWORK

A. Manufacturers:

1. ATCO Rubber Products.
2. Flexmaster.
3. JPL (J.P. Lamborn Co)
4. Thermaflex.

B. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regard to required quality of construction and materials.

C. Insulated Flexible Ductwork: Provide duct fabric of ply-vinyl film, polyethylene film or multiple layers of aluminum laminate supported by helically wound spring steel wire. Wrap fabric with fiberglass insulation and provide fire retardant polyethylene or reinforced metalized protective vapor barrier as specified herein.

1. Duct pressure class up to and including 6" w.g.
    a) Fire retardant polyethylene vapor barrier
        1) Flexmaster Type 5B
        2) JPL Type PR Series
        3) Thermaflex Type G-KM
    b) Reinforced metalized vapor barrier
        1) ATCO 30 Series
        2) Flexmaster Type 5M
        3) JPL Type MHP Series
        4) Thermaflex Type M-KE
    c) Polyester vapor barrier
        1) ATCO 70 Series
2. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
3. Provide acoustical, fiberglass insulated duct with minimum R-value of R-4.2.

D. Uninsulated Flexible Ductwork: Provide duct fabric of triple ply materials supported by helically wound spring steel wire.

1. Pressure Rating: 10 inches w.g. positive and 1.0 inches w.g. negative.
2. Maximum Velocity: 4,000 fpm.
3. Manufacturer:
    a) ATCO 050 Series
    b) Flexmaster 5NI-C
    c) JPL Type MNI

d) Thermaflex S-LD

2.13 FLEXIBLE ELBOW ASSEMBLY

A. Manufacturers:

1. Build Right Products, FlexRight Elbow.
2. Flexible Technologies, Inc,, FlexFlow Elbow.
3. Titus, FlexRight.

B. General: At Contractors option, in lieu of rigid sheet metal elbows at connections to air inlets and outlets in concealed spaces, provide flexible elbow assembly to air devices requiring a 90 degree elbow connection.

C. Flexible elbow assembly shall be constructed of durable composite material and UL listed for use in return air plenums with a turning radius of not less than 3 inches.

2.14 DUCT SILENCERS

A. Manufacturer:

1. BRD Noise and Vibration Control
2. Commercial Acoustics, Div. of Metal Form Manufacturing
3. Dynasonics
4. Industrial Acoustics (IAC)
5. Price Industries
6. Ruskin Company
7. SEMCO Inc.
8. United Sheet Metal
9. VAW Systems, Ltd.
10. Vibro-Acoustics

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA (DCS).

C. General Requirements:

1. Casing, sealants, adhesives, accessory materials, and packing materials to comply with ASTM E84.
2. Airstream surfaces installed in a return air plenum to comply with requirements in ASHRAE Std 62.1.
3. Factory-fabricated, field-installed products.

4. Provide internal support rods at locations as required to provide uniform support and to prevent the fan airflow from twisting the internal core.

5. Provide end connections compatible with the location being installed.

D. Geometry: Provide the following geometries as specified on the drawings.

1. Rectangular elbows with splitters or baffles.

E. Configuration:

1. Rectangular: Provide lined splitters with radiused nose and contour tails.

F. Materials:

1. Outer Casing: Minimum 22 gauge thick galvanized steel stiffened as required. Provide seams of the following:

a) Mastic filled lock formed.

b) Welded.

2. Inner casing and splitters: Minimum 22 gauge thick perforated galvanized steel.

3. Sound absorbing media: Media shall be incombustible, mildew resistant and vermin proof.

a) Acoustic quality, glass fiber insulation packed to minimum 5 percent compression.

b) Acoustic quality mineral wool.

c) Natural cotton or recycled natural fibers.

4. Fill Liner: Bonded glass fiber matting or mylar film designed to protect media from erosion.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Provide vanes in all supply and exhaust ductwork and in return and outside air ductwork that has an

air velocity exceeding 1000 fpm. Do not install vanes in grease or dryer exhaust ductwork.

C. Provide combination fire and smoke dampers, fire dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction.

1. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

2. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.

3. Demonstrate re-setting of fire and fire/smoke dampers to Owner's representative.

D. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

1. Provide duct access doors in ductwork at the following locations

a) At each change in direction and at maximum 50-foot (15-m) spacing.

b) Upstream [and downstream] from turning vanes.

c) Upstream or downstream from duct silencers.

2. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1" lettering) indicating which damper type is served. Door should be capable of being fully opened or provide removable door.

a) DUCT ACCESS DOOR SCHEDULE

Duct Width/Depth (in)	Door Size (in)	Quantity
10 to 12	10x10	1
14 to 18	12x12	1
20 to 36	14x14	1
38 to 54	18x18	1
56 to 72	18x18	2 (1 each end)
74 to 96	20x20	2 (1 each end)

3. As an alternate to duct access door for fire damper access in ducts 12 inch and smaller in each direction, a removable duct section can be provided. The duct section shall be Langdon Inc. "Sure Clamp Access" or approved equal with the following features:

a) Be removable without use of tools.

b) Be within 4 inches of the damper sleeve break away connection.,

c) Be insulated same as connected ductwork.

d) Have same pressure rating as the duct.

e) Have gaskets at seams to seal the connections.

4. Provide duct access doors for cleaning kitchen exhaust ducts in accordance with NFPA 96. Review locations prior to fabrication.

E. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.

1. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

2. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

F. Smoke Detectors: Provide detectors as shown on drawings.

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.

2. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

3. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

4. Coordinate with Division 26 for power wiring and interlocks.

5. Duct Smoke Detectors: Comply with NFPA 72, and NFPA 90A where adopted by the local AHJ. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.

a) Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.

b) Air handling units with smoke detection that serve fan-powered terminal units:

1) Provide duct detection and shutdown fan-powered terminal units that are less than 2,000 cfm when the respective air handling unit shuts down.

2) Provide individual duct detection and shutdown for each fan-powered terminal unit exceeding 2,000 cfm.

c) Provide duct detection and shutdown for air distribution systems exceeding 2,000 cfm.

G. Provide volume control dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual volume control damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.

H. Provide cable operated volume dampers with remote operators where access to dampers through a hard ceiling is required.

1. Support cable assembly to avoid bends and kinks in cable.

I. Install grease exhaust and fire rated duct wrap in accordance with manufacturer's instructions to provide the fire rating of the material as tested per UL requirements. Joint at insulation seam, banding, pins, and fire stop systems shall be installed as per manufacturers UL listing and manufacturers published installation instructions. Overlap seams, install stainless steel bands and/or pins to secure wrap to duct and fill annular spaces in floor and wall penetrations with UL rated forming materials and/or putty to maintain the integrity of the system.

J. Install flexible ductwork in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.

1. Flexible ductwork runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.

2. Install flexible ductwork straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible ductwork fully extended minimizing compression.

3. Provide continuous length with no intermediate joints.

4. Support flexible ductwork from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.

5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.

6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.

a) Factory installed suspension systems are acceptable

7. Do not crimp flexible ductwork against joist or truss members, pipes, conduits, etc.

8. Install flexible ductwork with bend radius at the center line equal to or greater than one duct diameter.

a) Support bends approximately one duct diameter on both sides of bends.

9. Connect flexible ductwork to sheet metal ductwork and air devices with at least 1" overlap.

K. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.

L. Install duct silencers at locations indicated on the drawings with straight sections of upstream and downstream ductwork as recommended by the manufacturer.

1. If the silencer is installed in a location exposed to water or weather, the fill shall be completely encapsulated in mylar bagging. The mylar bagging shall not degrade the acoustical performance of the silencer.

M. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.03 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

B. After start-up, final corrections and balancing of systems, test duct silencers by taking octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed. Refer to Division 23 Section "Testing, Adjusting and Balancing of HVAC" for additional requirements.

1. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.

2. Submit complete report of test results including sound curves.

3.04 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".

C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Tubeaxial fans.

1.02 SUBMITTALS

A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data: Provide data on axial fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements. Include the following:

1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
2. Materials gages and finishes, including color charts.
3. Dampers, including housings, linkages, and operators.

C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.03 QUALITY ASSURANCE

A. AMCA Compliance:

1. Provide propeller, tubeaxial, vaneaxial and mixed flow fan products that meet performance requirements and are licensed to use the AMCA Seal.
2. Provide HVLS fans that are tested and labeled in accordance with AMCA 230 “Laboratory Methods of Testing Air Circulation Fans for Rating and Certification”.
3. Provide jet fans that are tested and certified by AMCA.

4. Testing Requirements: The following factory tests are required for propeller, tubeaxial, mixed flow and vaneaxial fans:

a) Sound Power Level Ratings: Comply with AMCA Standard 301 "Certified Ratings Program Product Rating Manual for Fan Sound Performance". Test fans in accordance with AMCA Standard 300 "Reverberant Room Method for Sound Testing of Fans". Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

b) Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating".

B. UL Compliance: Fans and components shall be UL listed and labeled.

1. Fans used in grease exhaust applications shall be certified in accordance with UL 762.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.05 FIELD CONDITIONS

A. Permanent fans may not be used for ventilation during construction.

B. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.01 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.5.

D. Belts: Oil-resistant, non-sparking, and non-static.

1. Fans used for smoke control applications shall have 1.5 times the number of belts required for the design duty with a minimum of two belts.

E. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

F. Motor and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

1. Belt Guards: Provide OSHA compliant steel belt guards for motors mounted on the outside of the fan cabinet.

G. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.

2.02 TUBEAXIAL FANS

A. Manufacturers:

1. Cook (Loren) Co.
2. Chicago Blower Corp.
3. Greenheck Fan Corp.
4. Hartzell Fan, Inc.
5. PennBarry.

B. Description: Belt-driven or direct-drive as indicated, tubeaxial fans consisting of fan wheel and housing, inlet/outlet cone section as indicated, factory-mounted motor, and accessories.

C. Casing:

1. Steel casing, 12-gage minimum.
2. Continuously weld, with flanged inlet and outlet connections, and motor or shaft supports.
3. Guide Vane Section: Integral guide vanes downstream of the fan wheel designed to straighten the airflow for fans specified for static pressures greater than 1 in-wc..

D. Propeller: Fixed pitch, one piece cast aluminum, axial-flow type, with airfoil-shaped blades keyed and secured to shaft with a split taper bushing and retaining plate.

E. Bearings and Drives:

1. Belt Drive:

a) Factory mounted, with adjustable alignment and belt tensioning.

b) Fan Pulleys: Cast iron, keyed and secured to shaft with set screw for use with motors through 5hp; cast iron, keyed and secured to shaft with split taper bushing for use with larger motors; dynamically balanced at factory.

c) Motor Pulleys: Adjustable pitch, keyed and secured to shaft with set screw for use with motors through 5hp; fixed pitch, keyed and secured to shaft with split tapered bushing for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

d) Motor Mount: Adjustable base.

e) Shaft Bearings: Radial, self-aligning ball or roller type bearings in a cast iron pillow block housing.

1) Ball-Bearing Rating Life: ABMA STD 9, L10 life in excess of 50,000 hours.

2) Roller-Bearing Rating Life: ABMA STD 11, L10 life in excess of 50,000 hours.

2. Direct Drive: Encase motor in housing outside of airstream.

3. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

4. Lubrication: Extend lubrication lines to outside of casing and terminate with grease fittings.

F. Accessories:

1. Inlet Bell: Bell mouth inlet of same material as casing.

2. Outlet Cone: Transition of same material as casing with outlet area to inlet area ration of 1.5 to 1.0, with center pod as recommended by manufacturer.

3. Inlet Screens: Provide wire mesh screen of same material as casing where inlet is not connected to ductwork.

4. Outlet Screen: Wire-mesh screen of same material as casing, where outlet is not connected to ductwork.

5. Access Door: Bolted door of same material as casing to allow limited access to internal parts of fan including the bearing cover.

6. Swing-out Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as casing.

7. Mounting Feet: Feet bolted to the inlet and outlet flanges to facilitate mounting to the floor, ceiling, or wall that can be used with vibration isolators.

8. Mounting Brackets: Brackets welded in place to facilitate suspension of unit in either the vertical or horizontal configuration designed for use with vibration isolators.

9. Motor Cover: Cover of same material as casing, with side vents to dissipate motor heat.

10. Exterior Up-blast Discharge Assembly: Curb cap, motor cover, panel and butterfly dampers used in conjunction with a roof curb to utilize unit as a roof up-blast unit.

G. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.

2. Exterior Surfaces: Baked-enamel finish coat after assembly.

3. Coatings: Hot-dip galvanized.

a) Apply to finished casings.

b) Apply to fan wheels.

PART 3 - EXECUTION

3.01 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

3.02 INSTALLATION

A. Install fans level and plumb, in accordance with manufacturer's written instructions.

B. Support units using the vibration control devices indicated and specified in 23 0550 - VIBRATION ISOLATION FOR HVAC.

C. Arrange installation to provide access space around fans for service and maintenance.

D. Provide safety screen where inlet or outlet is exposed.

3.03 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.04 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping blocking and bracing.
2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
    a) Replace fan and motor pulleys as required to achieve design conditions.
    b) Measure and record motor electrical values for voltage and amperage.
    c) Shut unit down and reconnect automatic temperature control operators.
    d) Refer to 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC for procedures for air-handling-system testing, adjusting, and balancing.

3.05 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and 23 0010 - GENERAL MECHANICAL REQUIREMENTS"

B. Schedule training with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Centrifugal fans for indoor installations

B. Plenum fans

1.02 SUBMITTALS

A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements. Include the following:

1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
2. Materials gages and finishes, including color charts.
3. Dampers, including housings, linkages, and operators.

C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Fan Belts: One set for each individual fan.

1.03 QUALITY ASSURANCE

A. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

B. UL Compliance: Fans and components shall be UL listed and labeled.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

F. UL 705 – Standard for Power Ventilators, Underwriter's Laboratory, most current edition.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.05 FIELD CONDITIONS

A. Permanent fans may not be used for ventilation during construction.

B. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.01 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel, designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating".

D. Sound Ratings: Comply with AMCA 301 "Certified Ratings Program Product Rating Manual for Fan Sound Performance". Test fans in accordance with AMCA 300 "Reverberant Room Method for Sound Testing of Fans".

E. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.4.

F. Belts: Oil-resistant, nonsparking, and nonstatic.

1. Fans used for smoke control applications shall have 1.5 times the number of belts required for the design duty with a minimum of two belts.

G. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

H. Motor and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

1. Belt Guards: Provide OSHA compliant steel belt guards for motors mounted on the outside of the fan cabinet.

I. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.

J. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.

2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.02 CENTRIFUGAL FANS

A. Manufacturers:

1. CaptiveAire

2. Chicago Blower Corp.

3. Cook (Loren) Co.

4. Greenheck Fan Corp.

5. Hartzell Fan, Inc.

6. PennBarry.

B. General Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

C. Housings:

1. Fabricate from formed and reinforced galvanized steel panels to form curved scroll housings, spot welded for AMCA 99 class I and II fans and continuously welded for AMCA Class III fans.

2. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, provide two additional coats of paint. Prime coating on aluminum parts is not required.

3. Inlet Cones: Spun metal.

4. Duct Connections: Flanged.

5. Panel Bracing: Steel angle-or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

D. Fan Wheels: Single-width single-inlet and/or double-width double-inlet, welded to cast-iron or cast-steel hub and spun steel inlet cone, with hub keyed to the shaft. Provide inlet flange and back plate for rigid attachment of blades.

1. Blade Materials: Steel or aluminum.

2. Blade Type: Backward-curved, flat-plate or airfoil type; forward-curved, airfoil type or radial.

E. Bearings and Drives

1. Bearings: Provide type indicated, having a median life "Rating Life" ABMA L(50) of 400,000, calculated in accordance with ABMA STD 9 9 for ball bearings and ABMA STD 11 for roller bearings

a) Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.

b) Grease-lubricated, self-aligning, pillow-block type; tapered roller bearings with double-locking collars and two-piece, cast-iron housing. Provide Zerk fittings for lubrication.

c) Grease-lubricated, self-aligning, pillow-block type, with double spherical roller bearings with adapter mount and two-piece cast-iron housing. Provide Zerk fittings for lubrication.

2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.

3. Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid-range. Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

4. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

5. Direct Drive: Provide support stand and enclosure for direct connection of motor to fan wheel.

F. Accessories: Provide the following accessories where indicated:

1. Access Doors: Latch-type handles; flush-mounted for uninsulated housings and raised-mounted for insulated housings.

2. Drain Connections: Threaded, 3/4-inch NPS, capped nipple installed at lowest point of housing.

3. Spark-Resistant Construction: AMCA construction option A, B, or C as indicated.

2.03 PLENUM FANS

A. Manufacturers:

1. Chicago Blower Corp.
2. Cook (Loren) Co.
3. Greenheck Fan Corp.
4. Hartzell Fan, Inc.
5. PennBarry.

B. General Description: Plenum, direct or belt-driven, centrifugal fans consisting of housing, wheel, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

C. Housing: Panels and framework shall be constructed of heavy gauge steel. Framework shall provide a rigid structure to support the motor, fan, shaft and bearings and minimize low frequency vibration.

D. Fan wheel shall be plenum type with backward-inclined or airfoil blades. Blades shall be continuously welded. Fan wheel, blades and hub shall be:

1. Steel painted with zinc chromate primer and an enamel finish coat.
2. Aluminum.

E. Provide heavy gauge spun aluminum inlet cone.

F. Bearings and Drives

1. Bearings: Provide type indicated, having a median life "Rating Life" ABMA L(50) of 400,000, calculated in accordance with ABMA STD 9 for ball bearings and ABMA STD 11 for roller bearings
   a) Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
   b) Grease-lubricated, self-aligning, pillow-block type; tapered roller bearings with double-locking collars and two-piece, cast-iron housing. Provide Zerk fittings for lubrication.
   c) Grease-lubricated, self-aligning, pillow-block type, with double spherical roller bearings with adapter mount and two-piece cast-iron housing. Provide Zerk fittings for lubrication.
2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
3. Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under,

selected so required rpm is obtained with sheaves set at mid-range. Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

4. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

5. Direct Drive: Provide support for direct connection of motor to fan wheel.

G. Steel frame shall be constructed of ASTM-A36 steel, continuously welded at all connections.

H. Accessories: Provide the following accessories where indicated:

1. Inlet Connections: Provide inlet collar with flange for flanged duct connection.

2. Isolation Base: Provide welded steel isolation base with brackets for free standing or housed spring isolators. Refer to 23 0550 - VIBRATION ISOLATION FOR HVAC for spring isolators.

3. Extended Lubrication Lines: Provide extended lubrication line kits with minimum 25 feet of flexible tubing.

4. Spark-Resistant Construction: AMCA construction option A, B, or C as indicated.

PART 3 - EXECUTION

3.01 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

3.02 INSTALLATION

A. Install fans level and plumb, in accordance with manufacturer's written instructions.

B. Support units using the vibration control devices indicated and specified in Division 23 Section "Vibration Isolation for HVAC ."

C. Arrange installation to provide access space around fans for service and maintenance.

3.03 EQUIPMENT BASES

A. Construct concrete equipment pads in accordance with Division 23 Section “Common Work Results for HVAC”.

3.04 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.05 STARTUP

A. Final checks before start-up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
    a) Replace fan and motor pulleys as required to achieve design conditions.
    b) Measure and record motor electrical values for voltage and amperage.
    c) Shut unit down and reconnect automatic temperature control operators.
    d) Refer to 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC for procedures for air-handling-system testing, adjusting, and balancing.

3.06 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and 23 0010 - GENERAL MECHANICAL REQUIREMENTS "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable Air Volume Terminal Units

1. Shutoff Single Duct
2. Reheat

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; certified sound power data for each unit; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components and electrical characteristics and connection requirements.

C. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.

D. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.

E. Nameplate Data: Nameplate data shall be submitted in a timely manner so as to allow proper coordination with the Electrical Contractor. Submittals that do not have nameplate data will be rejected.

F. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

G. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 1.

1.03 QUALITY ASSURANCE

A. ADC Compliance: Provide air terminals that have been tested and rated in accordance with ADC standards, and bear ADC Seal.

B. AHRI Compliance:

1. Provide air terminals that have been tested and rated in accordance with AHRI 880 "Performance Rating of Air Terminals" and bear AHRI certification seal.

2. Provide air terminals that meet the scheduled sound performance in compliance with AHRI 885 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets".

C. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

D. UL/ETL Compliance: Air terminal units shall be UL or ETL listed as a complete assembly. All electrical components shall be UL listed and installed in accordance with the National Electric Code.

1.04 SPARE PARTS

A. If HVAC equipment is used during construction, the contractor is fully responsible for it's cleaning just before substantial completion prior to testing and balancing. The contractor is to provide one set of filters when the unit is started over the return duct opening throughout construction. Filters shall be changed during construction as needed, but not less than once every month. On the day of substantial completion, the contractor shall provide one complete set of filters for the unit and then provide one additional set as spare stock to the Owner. Obtain receipt from Owner that spare filters have been provided.

PART 2 - PRODUCTS

2.01 VARIABLE AND CONSTANT AIR VOLUME TERMINAL UNITS

A. Manufacturers:

1. Environmental Technologies, Inc.
2. Greenheck
3. Johnson Controls, Inc.
4. Krueger Mfg. Co.
5. Metalaire.
6. Nailor Industries, Inc.
7. Price Industries.
8. Daikin
9. Titus Products Div.; Philips Industries, Inc.

B. Construction

1. Casings: Construct of galvanized sheet metal of minimum 22 gauge thickness or die-cast aluminum of minimum 20 gauge thickness.

a) Assembled with longitudinal lock seam construction.

b) Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 2% of specified air flow capacity with outlets sealed and inlets wide open.

2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes or rectangular where needed to meet airflow requirements.

3. Unit Discharge: Rectangular, with slip-and-drive connections.

4. Acceptable Liners:

5. Access: Provide removable panels in casings to permit access to air dampers, fans and other parts requiring service, adjusting, or maintenance.

a) Provide airtight gasket and quarter-turn latches.

6. Provide hanger brackets for attachment of supports.

7. Multiple Duct Connectors: For air terminals serving more than one air outlet, provide lined outlet plenum with duct collar, butterfly-type damper, and locking device in each outlet.

C. Sound Attenuator

1. Provide if required to meet scheduled acoustical performance requirements.

2. Construction to consist of a continuous extension of the casing and liner as required to achieve required attenuation.

3. At 2000 fpm inlet velocity, the additional differential pressure drop with attenuator not to exceed 0.2 inch wg.

4. All sound data shall be compiled in an independent ADC certified laboratory and in accordance with the latest version of AHRI 880. All units shall be AHRI certified and bear the AHRI certification label.

D. Primary Air Damper Assembly:

1. Heavy-gauge, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.

2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.

3. Incorporate low leak damper blades for tight airflow shutoff.

a) Air Leakage Past Closed Damper: Maximum two percent of unit maximum airflow at 3 inch wg inlet static pressure, tested in accordance with ASHRAE Std 130.

E. Electric Heating Coil:

1. Listed, open-coil design, factory-installed and slip-in-type, fully wired including integral control box.
2. 80/20 nickel-chrome heating elements.
3. Integral Control Panel: NEMA 250, Type 2 enclosure with hinged access door for access to all controls and safety devices.
4. Mercury contactors.
5. Secondary/primary over temperature protection.
6. Airflow switch.
7. Step Controller: Magnetic contactor (3-phase units only).
8. Disconnect switch (non-interlocking).
9. Fuses.
10. Provide SCR (Silicon Controlled Rectifier) controller.

F. Electrical Requirements:

1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.
3. All electrical components shall be UL or ETL listed or recognized and installed in accordance with the National Electrical Code.
4. All electrical components shall be mounted in a control box.
5. The entire assembly shall be UL or ETL listed (cETL in Canada) and so labeled.

G. Control Transformers: Factory supplied and mounted for electric and electronic control applications.

H. Controls: Provide controls accurate to 1.5 degrees F and adjustable from 65 degrees F to 85 degrees F. Provide air flow measurement station at terminal unit inlet. Provide control type as indicated below.

1. DDC (Direct Digital Control): Provide direct digital controls, compatible with direct digital control system specified in other Division 23 sections.
    a) The unit level controller to include the following:
        1) 24 VAC power terminal or RJ-12 Power connection.
        2) Port for thermostat connection.
        3) Service Port for diagnostic equipment.
        4) Damper actuator.
        5) LED indication for troubleshooting.
        6) Heating output signal(s).
        7) Cooling output signal(s).

8) Supply air temperature sensor input.

9) Contact closure input.

10) BACNET communication capability.

b) Include a factory-installed, unit-mounted direct-digital controller.

c) Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.

d) Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.

1) Occupied and unoccupied operating mode.

2) Remote reset of temperature or CFM set points.

3) Proportional, plus integral control of room temperature.

4) Monitoring and adjusting with portable terminal.

5) Time-proportional reheat coil control.

e) Room Sensor:

1) Compatible with temperature controls specified.

2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.

2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.

a) Sensor Requirements:

1) Plastic parts shall be fire-resistant, complying with UL 94.

2) Control tubing shall be protected by grommets at the wall of the air flow sensor's housing.

3) Furnished with multiple total and static pressure sensing ports and a center averaging chamber that amplifies the sensed air flow signal.

4) Provide sensor with a pressure transducer to interface with the building control system.

b) Signal accuracy: Provide accuracy within 5 percent throughout the terminal unit operating range.

3. Fan Powered Terminal Units: Provide 24 V auxiliary contact to interface with the building fire alarm system for automatic shutdown.

I. Identification: Provide label on each unit indicating Plan Number, cfm range, cfm factory-setting, and calibration curve (if required).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of three duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

3.03 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to scheduled minimum flow.

3.04 FIELD QUALITY CONTROL

A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.

1. Leak Test:

a) Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

b) Repair water leaks and retest until no leaks exist.

2. Operational Test:

a) After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

b) Test and adjust controls and safeties.

c) Replace damaged and malfunctioning controls and other equipment.

3.05 ADJUSTING AND CLEANING

A. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

B. Install new filters.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Ceiling air diffusers.

B. Registers and grilles.

C. Linear slot diffusers.

D. Nozzle diffusers.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows. Indicate selections on data.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

D. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

E. Color Samples for Initial Selection: Manufacturer’s color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

1.03 QUALITY ASSURANCE

A. Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing the Performance of Air Outlets and Inlets".

B. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

C. Provide air outlets and inlets bearing ADC Certified Rating Seal.

D. Test and rate sound data for air outlets and inlets in accordance with AHRI 885 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets (with Addendum 1)".

E. Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.04 SPARE PARTS

A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS

2.01 CEILING AIR DIFFUSERS

A. Manufacturers

1. Greenheck.
2. Metalaire; Metal Industries, Inc.
3. Nailor Industries, Inc.
4. Price Industries, Inc.
5. Titus HVAC

B. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

D. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.02 REGISTERS AND GRILLES

A. Manufacturers

1. Greenheck.
2. Metalaire; Metal Industries, Inc.
3. Nailor Industries, Inc.
4. Price Industries, Inc.
5. Titus HVAC

B. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

D. Ceiling Compatibility: Provide registers and grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of register and grille.

E. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

F. Floor Compatibility: Provide registers and grilles with border styles that are compatible with adjacent floor systems, and that are specifically manufactured to fit into floor construction with accurate fit and adequate support. Registers and grilles shall be rated for personnel foot traffic. Refer to general construction drawings and specifications for types of floor construction which will contain each type of floor register and grille.

G. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.03 LINEAR SLOT DIFFUSERS

A. Manufacturers

1. Titus HVAC

B. General: Except as otherwise indicated, provide manufacturer's standard linear slot diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide linear slot diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

D. Compatibility: Provide linear slot diffusers with border styles that are compatible with adjacent ceiling or wall systems, and that are specifically manufactured to fit into ceiling or wall with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling and wall systems which will contain each type of linear slot diffuser.

E. Linear Slot Diffusers: Slot diffusers shall be standard one-piece lengths up to 6-feet and shall be furnished in multiple sections greater than 6-feet.

1. Provide straight and curved sections as required to accommodate layout shown on the drawings.

2. Multiple sections shall be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components shall be provided by the manufacturer.

3. Where specified on the drawings, plenums shall be manufactured by the slot diffuser manufacturer. Plenums shall be internally insulated, by the manufacturer, with minimum ¼" thick, closed-cell insulation. Insulation shall not be made of fibrous material.

F. Types: Provide linear slot diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.04 NOZZLE DIFFUSERS

A. Manufacturers

1. Greenheck.

2. Metalaire; Metal Industries, Inc.

3. Nailor Industries, Inc.

4. Price Industries, Inc.

5. Titus HVAC

B. General: Except as otherwise indicated, provide manufacturer's standard nozzle diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide nozzle diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

D. Compatibility: Provide nozzle diffusers with frame that is compatible with adjacent ceiling or wall systems. Refer to general construction drawings and

specifications for types of ceiling and wall systems which will contain each type of nozzle diffuser.

1. Provide a felt gasket to be installed between the nozzle and frame to provide a tight air seal.

2. For duct mounted nozzles, provide a mounting ring for insertion of the diffuser.

E. Airflow Pattern: Nozzle shall have directional control of no less than 30 degrees of deflection and 360 degrees rotation.

F. Provide minimum 18 gauge galvanized steel plenum box where multiple nozzles are shown at one location.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to insure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.

C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 section “Air Duct Accessories”.

D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

E. Linear Slot Diffuser Installation:

1. For installations in a hard ceiling, install diffuser prior to installation of drywall. Use manufacturer’s hard ceiling clips for mounting to ceiling framing. Screws through face of diffuser are not acceptable.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.04 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Filtered grease scrubber units.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data:

1. Rated capacities.
2. Filter performance ratings and pressure drop data.
3. Fan performance characteristics.
4. Gages and finishes of materials.
5. Installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. ETL Compliance: Construct and install units in compliance with applicable ETL requirements and listings.
2. IMC Code: Comply with “Pollution Control Unit” article in Chapter 5 of the IMC.
3. NFPA Compliance:
    a) NFPA 70 National Electrical Code.
    b) NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
4. UL Compliance: Provide filtration, firestats, etc. per documents with UL ratings as specified.

a) Fans shall be listed and labeled in accordance with UL 762 – Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances.

b) Grease scrubbers shall be listed and labeled in accordance with UL 1978 – Standard for Grease Ducts.

c) Grease scrubbers shall be listed and labeled in accordance with UL 8782 – Pollution Control Units for Commercial Cooking.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handle units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

B. Store units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading units and moving them to final location.

1.05 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for grease scrubber units.

1. One set of matched fan belts for each belt driven fan.

2. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.

3. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS

2.01 FILTERED GREASE SCRUBBER UNITS

A. Manufacturer: Filtered grease scrubber shall be part of a fully functional kitchen exhaust system including control panels, exhaust hoods, sensors, etc. as defined in mechanical and food service documents. Approved equal must prove the ability to meet all requirements of the construction documents at no additional cost to Owner.

1. Accurex.

2. CaptiveAire.

3. Halton.

4. Approved equal.

B. General: Provide filtered grease scrubber units having cabinet sizes to fit locations indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit cabinet, fan board, odor control, fans, housing, motor, and filters.

C. Insulation: Minimum 1 inch fire-proof mineral insulation of walls, floors, and roof.

D. Cabinet Construction: Provide manufacturer's standard construction of carbon or stainless steel that meets the fire ratings of UL and NFPA 96.

1. Supporting Base: Comprised of full-length structural longitudinal and cross-bracing channel members.

E. Fans: Provide Class T2 construction fan assembly of centrifugal utility or tubular inline type with airfoil or backward inclined curved non-overloading type blades. Blower shall be licensed to bear the AMCA Certification Seal. Provide hardened steel fan shaft with anti-friction ball pillow block type bearings.

F. Motors: Provide TEFC inverter rated motor with V-belt drive. Provide factory mounted combination starter/disconnect or variable frequency drive with disconnect as scheduled.

G. Isolation: Internally isolate fan and motor assembly.

H. Access Doors: Provide units with hinged access doors with toggle-type latches. Provide doors of double-wall construction with inner and outer walls of 16-gauge steel. Include ETL listed fire rated gaskets to form a grease tight seal when closed.

I. Filters: Provide filtration system for particulate grease and smoke abatement that removes a minimum of 95 percent of the grease and smoke. Refer to the equipment schedule on the drawings for additional information.

J. Accessories: Provide the following accessories as indicated and/or scheduled:

1. Wet-Chemical Fire-Suppression System:

a) Factory Provided Components: Provide ANSUL, Amerex, or equal brand fire suppression pre-piping and suppression nozzles facing the lead face of the first filter bank and the trailing face of the final filter bank. Piping and nozzles to be factory installed by certified technicians. Fire-suppression system shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

b) Field Provided Components: Fire suppression system, chemical supply system and activation devices shall be field supplied per below.

1) Steel Pipe, NPS 2 inch and Smaller: ASTM A53/A53M, Type S, Grade A, Schedule 40, plain ends.

2) Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

3) Pipe Covers: Chrome-plated aluminum tubing.

4) Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be field installed. Controls shall be in stainless-steel control cabinet mounted on wall. Furnish manual pull station for wall mounting adjacent to hood. Fusible link shall be field mounted in unit on factory provided mounting bracket within unit, coordinate with manufacturer.

5) Liquid Extinguishing Agent: Noncorrosive, low-pH liquid (R102).

6) Fire-suppression system shall be initiated by field installed unit fusible link or manual pull station as described above.

2. Provide factory mounted and wired firestat within filter section to shut down unit fan and generate an alarm at unit status panel. Firestat to be activated at or above 200 degrees Fahrenheit.

3. Provide differential pressure monitoring system with pressure sensors across each filter stage with pressure sensors wired to send signals to the remote status panel.

4. Provide manufacturer's remote status panel with NEMA 4X enclosure, ETL listed, and housing constructed of 304 stainless steel with water-tight access door.

a) include fuse-protected circuitry, step-down 24-volt transformer, unit prove out timer, relays, and status pilot light indicators in the face of the panel.

b) Provide indicators for fan on/off, power, filter out, fire, replace filter (first, second, and third stages each) alarm, and low odor liquid.

c) Provide auxiliary contact for any alarm condition signal to be sent to remote monitoring system (i.e. BAS).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of grease scrubbers.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATIONS

A. Install grease scrubber units in accordance with manufacturer's written instructions.

B. Roof Mounted Units: Secure roof-mounted units to roof equipment supports. Refer to the drawings for the type of support required for each unit.

1. Refer to Section "Hangers and Supports for HVAC Piping and Equipment" for standard roof curbs.

2. Refer to Section "Vibration Isolation For HVAC" for vibration isolation curbs.

C. Arrange installation of units to provide access space around units for service and maintenance.

3.03 CONNECTIONS

A. Duct installations and connections are specified in other Division 23 sections.

3.04 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Division 26 Contractor.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.05 ADJUSTING AND CLEANING

A. General: Just prior to substantial completion clean unit's exposed surfaces and vacuum clean internal components including fan wheel, fan cabinet, filter sections, access sections, etc.

B. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

3.06 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify unit is secure on mountings and supporting devices and that connections for ductwork and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

B. Start-Up Services: Start-up grease scrubber units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated CFM.

a) Replace fan and motor pulleys as required to achieve design conditions.

b) Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for system testing, adjusting, and balancing.

3.07 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum time as specified below on the operation and maintenance of the equipment provided under this section.

1. Two hours.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Dryer vent fans.

1.02 SUBMITTALS

A. Product Data:

1. Provide data on fans including materials of construction, fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

2. Provide data on dampers including materials of construction and airflow performance.

3. Provide data for each controller including performance characteristics, electrical characteristics, finishes of materials, installation instructions and start-up instructions.

B. Shop Drawings: Show fabrication and installation details for products. Include plans, elevations, sections, details, and attachments to other work. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

1. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring..

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, fan lubrication procedures, spare parts list, and maintenance and repair data.

D. Warranties: Special warranties specified in this Section.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Mechanical draft system shall be guaranteed to operate to provide a constant draft that does not fluctuate more than +/- 0.01 inch W.C. under stable load conditions.

C. Venting system shall comply with NFPA 54 "National Fuel Gas Code” to satisfy Factory Mutual (FM) Global Insurance requirements.

D. Draft ventilators shall meet UL Standard 378 “Standard for Draft Equipment’.

E. Draft vent controllers shall contain features in compliance with UL Standard 378 “Standard for Draft Equipment’.

1.04 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of draft control system that fail in materials or workmanship within specified warranty period.

1. Failures include failure of the fan due to corrosion.

2. Warranty Period: Two years from date of Substantial Completion.

B. Vent Exhaust Fan System Warranty: Provide a ten year warranty against corrosion perforation from the date of substantial completion. The warranty shall include 100 percent coverage of a contractor’s response within a 24 hour Owner request.

PART 2 - PRODUCTS

2.01 DRYER VENT FANS

A. Manufacturers:

1. Enervex.

2. Tjernlund Products Inc.

3. Fantech.

B. General Description: Direct-drive, variable speed motors, mechanical fans consisting of fan wheel and housing, factory-mounted motor, and accessories. Fans shall be listed in accordance with UL 705. Assembly shall be rated for operating temperatures up to 350 degrees F.

C. Housings: Steel with corrosion resistant finish or cast aluminum, with duct connections designed to minimize lint collection.

1. Designed to allow the entire impeller and motor assembly to be removed as a unit.

2. Provide a service door for cleaning and service.

D. Wheels: Cast-aluminum, statically and dynamically balanced.

E. Motor: Totally enclosed, fan-cooled, variable speed, pre-lubricated and sealed ball bearings, Class B insulated.

F. Variable frequency drive shall be as specified in Division 23 Section “Variable Frequency Drives for HVAC”.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Install listed components in a manner conforming to the listing.

C. Install support plates prior to installing inducer fan or dampers.

3.02 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

B. Connect wiring according to Division 26 Section "Common Work Results for Electrical".

3.03 STARTUP

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Electrical: Verify that electrical wiring installation complies with manufacturer’s submittal and installation requirements of Division 26 Sections. Do not proceed with startup of fans or equipment served until wiring installation is acceptable to equipment installer.

D. Remove and replace malfunctioning components and recheck.

E. Startup: Contractor shall startup and demonstrate operation of system as follows:

1. Start system according to manufacturer’s instructions.
2. Operate and adjust controls and safeties.
3. Operate system including accessories and controls, to demonstrate compliance with requirements.

3.04 ADJUSTING

A. Set field-adjustable switches and controls as indicated.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain draft control devices. Refer to Division 1 and Division 23 Section “General Mechanical Requirements”.

3.06 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum time as specified below on the operation and maintenance of the equipment provided under this section.

1. Two hours.

2. Four hours.

3. Eight hours.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable refrigerant volume HVAC system:

1. Outdoor/condensing units.
2. Indoor/evaporator fan coil units.
3. Refrigerant piping and components.
4. Individual room controllers.
5. Central control system.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers and a manufacturer's representative.

1.03 SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics. Provide data that indicate size, profile, weight and dimensional requirements of equipment.
   a) Indicate maximum number of indoor units served.
   b) Indicate maximum refrigerant piping run from outdoor units to indoor units.
   c) Indicate maximum height difference between outdoor and indoor units both above and below.
2. Refrigerant:
   a) Provide data indicating type and quantity for each specified equipment type.
   b) Provide analysis report indicating refrigerant volumes for proper charging based on installed layout and statement of code compliance for maximum allowable system volume for the smallest room in the event of an accidental refrigerant release for review by the engineer of record.

3. Performance data for any sound mitigating devices required to meet space or environmental acoustical characteristics.

4. Performance data verifying system heating capacity meets the scheduled heating capacity without supplemental electric heat at the design heating ambient temperature.

    a) Where supplemental heat is allowed, the supplemental electric heat shall be included in the submitted system efficiency rating.

B. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts.

1. Base drawings on the specific system indicated.

2. Provide floor plans that indicate quantity and location of indoor and outdoor units that satisfy the scheduled system capacity and zone temperature control; location of refrigerant control boxes; and refrigerant pipe quantity, sizing and routing.

3. Clearly indicate exceptions to basis of design on floor plans and submittals where appropriate.

    a) Exceptions requiring additional construction related costs (materials and labor) shall be coordinated and shall be included at no additional cost to the owner.

4. Provide diagrams for power, signal, and control wiring.

5. Provide refrigerant piping installation drawings and details.

6. Provide refrigerant piping diagrams.

7. Indicate condensate piping and power connection locations to be connected by others and identify any additional connections required due to changes in system configuration due to differences in product offerings from basis of design manufacturer.

C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

D. VRF installer current training certificates signed by manufacturer’s designated training agent in compliance with requirements specified under Article "Quality Assurance" below.

E. Training certificates of VRF system startup representative in compliance with requirements specified under Article "Quality Assurance" below.

F. Test reports and checklists specified in Part 3 Article “Field Quality Control,” “Startup,” and “Training.”

G. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guides in the Operation and Maintenance manuals.

1. Include manufacturer's recommended maintenance schedule for units installed in a seacoast application, within 5 miles of the coast.

H. Confirmation of manufacturer site visits required in Part 3 Article "Field Quality Control."

1.04 QUALITY ASSURANCE

A. Contractor Qualifications: Qualifications below based on VRF type scheduled on the drawings (Heat Pump VRF or Heat Recovery VRF).

1. Contractor shall have successfully completed three VRF projects within the last three years.

2. Contractor shall have successfully completed at least 100 total tons of VRF projects within the last three years.

3. Contractor shall have successfully completed at least one VRF project 50 tons or larger within the last three years.

B. Certified Piping Installers:

1. Certified by the manufacturer or manufacturer's representative.

2. Present on-site during construction to provide supervision and quality assurance inspection of the VRF piping installation.

3. Quantity: Minimum of two.

4. If the certified training has not been completed within the last 12 months prior to the construction start date, the manufacturer or manufacturer's representative shall conduct a minimum 2 hour refresher training class.

C. Startup Supervision:

1. Complete startup of system by the manufacturer or a duly authorized, trained representative.

2. Provide proof of manufacturer certification indicating successful completion of training within two (2) years of system installation.

D. Regulatory Requirements:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 "National Electrical Code", Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Comply with ASHRAE 15 “Safety Standard for Refrigeration Systems” and the local mechanical code for the total quantity of refrigerant within a given system installation.

3. Design units to operate with HCFC-or HFC free refrigerants.

4. Test units by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 "Heating and Cooling Equipment” and bear the Listed Mark.

5. Rate units in accordance with ANSI/AHRI Standard 210/240 “Performance Rating of Unitary Air-Conditioning & Air-source Heat Pump Equipment” and 1230 “Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute”.

6. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

7. Mechanical equipment for wind-born debris regions shall be designed in accordance with the most recent edition of ASCE 7 and installed to resist the wind pressures on the equipment and the supports.

1.05 FLAMMABLE REFRIGERANTS

A. Equipment with refrigeration systems using Group A2L refrigerants shall meet all requirements of ASHRAE Std 15 and this section.

B. Listing and Installation Requirements:

1. Listed in accordance with UL 484 or UL 60335-2-40/CSA C22.2 No. 60335-2-40.

2. The nameplate shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing.

3. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing.

C. Refrigeration systems shall have an integral refrigerant detection system that meets the following requirements as documented in ASHRAE Std 15:

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.

2. Field recalibration of refrigerant detection system shall not be permitted.

3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.

4. Have access for replacement of refrigerant detection system components.

5. Have self-diagnostics to determine operational status of the sensing element.

6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.

7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, -1%).

D. Manufacturer's refrigeration mitigation action shall be completed in not more than 15 seconds after the initiation of the output signal of the equipment's integral refrigerant detection system and shall be maintained for at least 5 minutes after the output signal has reset.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle equipment according to manufacturer's recommendations.

B. Protect equipment from weather, extreme temperature, etc. as recommended by the manufacturer.

1.07 WARRANTY

A. Parts Warranty: Provide written manufacturer parts warranty for a period of 10 years from the date of startup. Warranty shall cover replacement and/or repair of parts with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only and does not include labor for removal and reinstallation.

B. Warranty Labor Service: Provide written full parts and labor warranty for a period of 1 year from date of startup, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. Warranty shall cover replacement and/or repair of parts with inadequate or defective materials and workmanship. Warranty labor service shall be provided by a factory authorized and trained service technician.

1.08 SPARE PARTS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Disposable Air Filters: Furnish two complete sets.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Carrier.

B. Daikin US Corporation.

C. Lennox.

D. Mitsubishi Electric.

E. Trane.

2.02 REFRIGERANT SYSTEM

A. Piping: Refer to Section “VRF Refrigerant Piping” for refrigerant piping, tubing, fittings, valves and piping, specialties.

B. Refrigerant: Operate with refrigerant as scheduled on the drawings or refrigerant used by manufacturer selected for the installation..

C. Oil: As required by VRF HVAC system manufacturer and to comply with performance requirements indicated

2.03 OUTDOOR/CONDENSING UNITS

A. Construction:

1. Completely factory assembled, pre-wired, and tested with all necessary electronic and refrigerant controls.
2. Include compressors, motors, heat exchangers, fans, condenser coil, expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut-off valves, oil separators, service ports, and refrigerant regulator, as required, to perform system intent.
3. Designed specifically for use with VRF series components.
4. Capable of connecting an indoor evaporator capacity up to 125% to that of the condensing unit capacity. All indoor units are each capable of operating separately with individual temperature control.
5. Wired and piped with unit access from the left, right, rear or bottom.
6. Automatically restart operation after a power failure without causing any settings to be lost, thus eliminating the need for re-programming.
7. Modular in design allowing for side-by-side installation with minimum spacing.
8. Provide safety devices including;
    a) High pressure sensor and switch
    b) Low pressure sensor

c) Oil level sensor.

d) Control circuit fuses.

e) Crankcase heaters.

f) Fusible plug.

g) Overload relay.

h) Inverter overload protector.

i) Thermal protectors for compressor and fan motors.

j) Over current protection for the inverter.

k) And anti-recycling timers.

9. Provide a sub-cooling feature in the refrigerant circuit to ensure liquid refrigerant does not flash when supplying to the various indoor units.

10. Employ an oil management system that ensures equipment is properly protected for the life of the equipment. Any oil recovery cycles shall not cause occupant discomfort or erratic system operation.

11. Charge all units and refrigerant pipes with dehydrated air or dry nitrogen prior to shipment from the factory.

B. Unit Cabinet:

1. Provide cabinet that is completely weather-proof and corrosion resistant, constructed of galvanized steel finished with powder coat baked enamel paint.

2. Provide removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

3. Provide protective coating for coastal application: Provide manufacturer's recommended finish for seacoast corrosion protection.

C. Fan and Motors:

1. One or more direct-drive, variable speed propeller type fans.

2. Vertical discharge airflow.

3. Equip with a dip switch to accommodate additional external static pressure from optional air guides.

4. Provide motor with inherent protection and permanently lubricated bearings.

5. Provide motor with a fan guard to prevent contact with moving parts.

D. Condenser Coil:

1. Air cooled

a) Manufacture from copper tubes expanded into aluminum fins to form a mechanical bond.

b) Provide waffle louver or smooth plate fin and rifled bore tube design.

c) Factory treat coil and fins with anti-corrosion coating.

E. Compressor and Motor Assembly:

1. Provide a minimum of one hermetically sealed, inverter controlled, inverter driven compressor to modulate capacity. Capacity shall be variable from 20 to 120 Hz, modulating in 1 Hz or smaller increments. Provide additional hermetically sealed, digitally controlled, inverter driven compressors as needed to meet specified capacity.. Non-inverter compressors shall not be allowed.

2. Provide inverter driven compressors capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.

3. Sample evaporator and condenser temperatures so that the high/low pressures detected are read maximum of every 20 seconds and calculated. Control compressor capacity to eliminate deviation from target value.

4. Provide capacity control range as low as 15% to 100%.

5. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

6. Provide oil separators with the equipment together with an intelligent oil management system to ensure safe and proper lubrication over entire operating range.

7. Provide integral vibration isolation.

8. In the case of multiple condenser modules, compressor run time shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Provide manufacturer's standard enclosure, suitable for unprotected outdoor locations.

2. Provide factory-installed controller with configurable digital control.

3. Provide the following factory-installed sensors:

a) Refrigerant suction temperature.

b) Refrigerant discharge temperature.

c) Outdoor air temperature.

d) Refrigerant high pressure.

e) Refrigerant low pressure.

f) Oil level.

4. Provide self-diagnostics, time delay, auto-restart, and fuse protection features. Provide control modes to meet sequence of operation specified on the drawings.

5. Capable of network communication with indoor units and other outdoor unit(s).

6. Provide manufacturer's standard cable and wiring with each connection labeled and corresponding to a unit-mounted wiring diagram.

7. Provide manufacturer's standard field connections labeled and corresponding to a unit-mounted wiring diagram.

H. Electrical:

1. Provide metal enclosure, similar to cabinet enclosure, and suitable for unprotected outdoor locations.

2. Provide single point field connection to power entire unit and integral controls.

3. Provide factory-mounted circuit breaker or disconnect switch, complying with NFPA 70.

4. Provide control transformer coordinated with field power supply.

5. Provide wiring with each connection labeled and corresponding to a unit-mounted wiring diagram.

6. Electrical service requirements shall be as scheduled on the drawings.

I. Unit Piping:

1. Provide copper tubing with brazed joints.

2. Provide insulation, of thickness to prevent condensation.

3. Factory pressure test piping and verify to be without leaks. Repair leaks and retest until piping passes pressure test.

J. Accessories:

1. Field Installed air guides to change discharge airflow direction from vertical to horizontal.

a) Factory fabricated.

b) Field fabricated.

2. Hail guard protective barrier to condenser coil.

3. Skid mounted option: Factory mounted and wired to a single power panel on a prefabricated skid. Power panel shall include separate power circuit for each independent refrigerant circuit. Skid shall have a single-point power connection to power panel. If skid mounted option is not available from the factory, engage a third party to install.

K. Supplemental Heat: When required to meet the low ambient design conditions specified, supplemental heat shall be integrated with the VRF equipment. See System Performance section for related information.

2.04 INDOOR/EVAPORATOR FAN COIL UNITS

A. Common System Components

1. Construction:

a) Completely factory assembled, wired and tested.

b) Include factory wiring, piping, electronic proportional or pulse modulating expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate safety shut off and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

c) Equipped with a return air thermistor.

d) Operate with electronic expansion valves with no exceptions or substitutions.

e) Charge all units and refrigerant pipes with dehydrated air or dry nitrogen prior to shipment from the factory.

2. Unit Cabinet:

a) Construct cabinet with sound absorbing foamed polystyrene and polyethylene insulation.

b) Provide filter rack to accommodate scheduled filters.

3. Fan and Motor Assembly:

a) Adjustable external static pressure settings for auto CFM adjustment at commissioning.

b) One or multiple fan assembly driven by a single motor.

c) Brushless digitally controlled or electronically commutated motor with permanently lubricated bearings.

d) Provide motor with integral protection against thermal, overload and voltage fluctuations..

e) Statically and dynamically balanced impeller.

f) Provide integral isolation to dampen vibration transmission.

4. Filter:
    a) As scheduled on the drawings.
    b) Washable long-life filter with mildew proof resin if not scheduled on the drawings.
5. Coil:
    a) Provide direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
    b) Provide waffle louver or smooth plate fin and rifled bore tube design.
    c) Provide aluminum, galvanized or stainless steel casing.
    d) Provide flare connections.
    e) Provide condensate pan under the coil.
    f) Provide thermistor on the liquid and gas line.
6. Outdoor Air Ventilation Connection: Provide sheet metal knockout for connection to outdoor air ventilation duct on units where shown or specified on the drawings.
7. Electrical:
    a) Electrical characteristics shall be as scheduled on the drawings.

B. Ceiling Concealed Ducted Unit
1. Unit Cabinet:
    a) Galvanized steel casing.
    b) Designed for concealed installation within the ceiling cavity.
    c) Horizontal front supply air opening and horizontal return air opening duct connections.
    d) Hanger brackets designed to support the unit weight on four corners. Hanger brackets shall have pre-punched holes designed to accept field supplied, all-thread rod hangers.
2. Provide the following accessories where scheduled on the drawings.
    a) Dry contact for local interlock of external devices.
    b) Condensate lift pump with a built in safety cut off switch.

C. Ceiling Concealed Slim Ducted Unit
1. Unit Cabinet:
    a) Galvanized steel casing.
    b) Low profile design for concealed installation within the ceiling cavity.

c) Horizontal front supply air opening and horizontal return air opening duct connections.

d) Hanger brackets designed to support the unit weight on four corners. Hanger brackets shall have pre-punched holes designed to accept field supplied, all-thread rod hangers.

2. Provide the following accessories where scheduled on the drawings.

a) Dry contact for local interlock of external devices.

b) Condensate lift pump with a built in safety cut off switch.

D. Wall Mounted Unit

1. Unit Cabinet:

a) Designed for installation against a vertical wall surface. Mounting brackets shall be factory supplied.

b) Discharge airflow guide vanes: Auto-swing feature that controls the vanes in an up/down direction.

c) Condensate drain piping connection from either left or right side.

2. Provide the following accessories where scheduled on the drawings.

a) Dry contact for local interlock of external devices.

b) Standard white finish unless otherwise scheduled on the drawings.

c) Field provided condensate pump, powered by the fan coil unit with a built-in safety cut off switch.

d) Condensate lift pump with a built in safety cut off switch.

2.05 INDIVIDUAL ROOM CONTROLLERS

A. General Requirements

1. Capable of controlling multiple indoor units in one group.

2. Programmable Functions:

a) Digital control capable of allowing at least a 2.5°F change in temperature away from setpoint prior to cooling/heating mode changeover.

b) Dehumidification program that dehumidifies while inhibiting changes in room temperature.

c) Support auto-changeover mode for heat recovery systems that switches the indoor unit mode between Cool/Heat according to the room temperature and temperature setpoint.

3. Service run tests used by service personnel to troubleshoot operation.

4. Error code notification display used by service personnel to troubleshoot abnormal operation and equipment failure.

5. Settings stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.

B. Programmable Wired Remote Controller

1. Required Display Features:

a) LCD display screen

b) Operation display.

c) Day of the week

d) Time of day configurable for 12/24 hour clock.

e) Temperature information configurable for Fahrenheit or Celsius in one degree increments.

f) Relative humidity display: 1 percent increments.

g) Malfunction notification or error codes

2. Required Operations:

a) On/Off

b) Operation Mode (Cool, Heat, Fan, Dry and Auto)

c) Adjustable temperature setpoint.

d) Adjustable relative humidity setpoint.

e) Fan speed

f) Airflow direction

g) Lockout functionality

3. Required Programmable functions:

a) 7-day scheduling: Selectable weekly pattern options of 7-day, Weekday + Weekend, or Weekday + Saturday + Sunday. A minimum of 5 operations shall be available per day in 1-minute increments.

b) Sense room temperature at either the controller or the indoor unit return air temperature sensor (or remote mount sensor) dependent on the field setting configured through the remote controller.

c) Sense room relative humidity at the indoor sensor.

d) Have field setting mode for setting up central control management.

C. Non-Programmable Wired Remote Controller

1. Required Display Features:

a) LCD display screen

b) Operation display

c) Temperature information configurable for Fahrenheit or Celsius in one degree increments.

d) Relative humidity in one percent increments.

e) Malfunction notification or error codes

2. Required Operations:

a) On/Off

b) Adjustable temperature setpoint.

c) Adjustable relative humidity setpoint.

d) Fan speed.

D. Wireless Remote Controller

1. The controller shall be used in conjunction with a remote mount sensor to sense room temperature.

2. Required Display Features:

a) Operation display.

b) Temperature information configurable for Fahrenheit or Celsius in one degree increments

c) Relative humidity in one percent increments.

d) Malfunction notification or error codes

3. Required Operations:

a) On/Off

b) Operation Mode (Cool, Heat, Fan, Dry and Auto)

c) Adjustable temperature setpoint.

d) Adjustable relative humidity setpoint.

e) Fan speed

f) Airflow direction

2.06 CENTRAL CONTROL SYSTEM

A. General Requirements

1. Capability to operate the system with or without a building automation system (BAS).

2. Capability to manage multiple VRF indoor units or groups of indoor units without requiring memory expansion kits.

3. Capability to manage multiple outdoor units from a single interface point with options for remote internet monitoring interface and malfunction reporting.

4. Capability to receive expansion kits to increase the management capacity of the controller.

5. Capability to be installed in a daisy chain configuration from the outdoor unit, to the system controller, to the power supply.

B. Required Display Features

1. On/Off.

2. Operation Mode.

3. Temperature setpoint.

4. Space temperature.

5. Space relative humidity.

6. Airflow Direction.

7. Fan Speed for Group/Zone.

8. Malfunction/Error.

9. Forced Stop.

10. Set Schedule/Setback/Auto-changeover.

11. Filter.

12. Screen Lock.

13. Date and day of the week along with the time of day (12hr or 24hr display selectable). Time shall adjust for daylight savings time (DST) automatically.

14. Updated display information maximum every 10 seconds (adjustable).

15. Temperature information configurable for Fahrenheit or Celsius in one degree increments.

16. System Setting Mode used to configure options and display information for each Zone or Group.

17. Zone Configuration:

    a) Capability to display a single indoor unit or a collection of indoor units blocked together for control and monitoring purposes.

    b) Capability to assign names to zones or groups of zones (e.g., Office 101, Lobby, North Hallway, etc.).

    c) Setpoint Range Limitation.

    d) Setback Temperature setting.

    e) Setback Relative Humidity setting.

    f) Auto-changeover.

18. Capability to display indoor units by Zone or Group.

19. Malfunction notification or error codes.

20. Communication errors between the central controller and the indoor units.

21. Error history shall be available for viewing the 10 most recent errors/abnormalities.

C. Required Operations

1. On/Off

2. Operation Mode (Cool, Heat, Fan, Dry, and Auto)

3. Adjustable temperature setpoints

4. The morning warmup/cooldown recovery differential shall be 40°F (default) and shall be adjustable.

5. Adjustable relative humidity setpoints

6. Fan Speed

7. Airflow direction (dependent upon indoor unit type)

8. Remote controller permit/prohibit of On/Off, Mode, and Setpoint

9. Lock out setting for central controller display

10. Lock out setting for individual zone controller display.

11. Indoor unit Group/Zone assignment

12. Battery backup power for the clock.

13. Settings stored in non-volatile memory

14. Scheduling

    a) Weekly schedule settings 7 day weekly pattern

    b) Weekday + Weekend

    c) Weekday + Saturday + Sunday

    d) Independent schedules configurable with multiple events settable for each day

        1) Each scheduled event shall specify time and target Area or Group

        2) Each scheduled event shall include On/Off, Operation Mode, Setpoint, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit.

15. Controller shall allow for exception days.

D. Auto-Changeover

1. Auto-changeover shall be programmed to allow automatically switching mode between Cool and Heat in accordance with the room temperature and setpoint using [Individual Method][Average Method].

    a) The setpoint differential shall be adjustable.

    b) The operational mode shall change when the room setpoint is exceeded by ±2.5°F (adjustable).

    c) A guard timer (adjustable) should be in place to prevent rapid changing, but is overridden if the room setpoint is changed.

E. Controller shall support interlock features for use with third party equipment to automatically control groups or zones corresponding to the change in operation status or on/off status.

F. Options

G. Building Automation System (BAS) Interface

1. Provide a gateway controller to integrate the VRF system with a third party BAS. Gateway shall allow BAS to control, schedule, and monitor all points associated with a manufacturer controller.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which VRF system components are to be installed.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping, tubing, ductwork, and electrical conduit and wiring to verify actual locations of connections before equipment installation.

D. Examine walls, floors, roofs, and outdoor supports for suitable conditions where equipment will be installed.

E. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 COORDINATION

A. Conduct a pre-construction meeting to coordinate the installation requirements of the VRF system for each division involved.

B. Coordinate size and location of concrete equipment bases. Cast anchor-bolt inserts into bases.

C. Coordinate central controller gateway and interface requirements with manufacturer and temperature controls contractor.

3.03 INSTALLATION OF VRF SYSTEM COMPONENTS

A. Install products in accordance with manufacturer's instructions.

B. Install indoor/evaporator units plumb and level, maintaining minimum clearance, and firmly anchored in locations indicated using manufacturer's standard mounting devices with vibration isolation as required in Division 23 Section "Vibration Isolation for HVAC."

1. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
2. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
3. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls

C. Install outdoor/condenser unit level, maintaining minimum clearance around the unit to avoid air recirculation and at minimum elevation for proper drainage. Isolate unit according to Section "Vibration Isolation for HVAC."

1. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases with support stands as needed to elevate units above snow depths. Anchor support stands to the concrete pad.
2. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section "Hangers and Supports for HVAC Piping and Equipment".

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

E. Ductwork: Refer to Division-23 Section "Metal Ducts" and "Air Duct Accessories". Connect supply and return ducts to split-system air-conditioning units (where applicable) with flexible duct connectors.

F. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Install the indoor units to the condensing unit utilizing manufacturer specified piping joints and headers to ensure correct refrigerant flow and

balancing. Field fabricated Tees, Y-fittings, Headers, or other branch fittings shall not be allowed.

2. Connect condensate drain piping to the unit with appropriate trap. Verify that the piping material and installation is in accordance with Division 22 requirements.

3. Refrigerant Control Box Drain Piping: Install condensate piping and additional floor drains, as required, to meet the drainage requirements per manufacturer recommendations.

4. Connect multiple circuits to a single refrigerant control box using manufacturer recommended fittings.

3.04 FIELD QUALITY CONTROL

A. Do not operate VRF systems to provide temporary conditioning during the construction period. If buildup of dirt, grime, dust, or construction debris is found in any of the system equipment the contractor shall be responsible for cleaning to like new conditions and verifying proper operations or replacing defective equipment.

B. Refer to Division 23 Section "VRF Refrigerant Piping" for leak testing, charging, and additional field quality control measures.

C. Site Visits: The manufacturer or the representative of the manufacturer shall conduct site visits for the following:

1. Installation Quality Inspections: Up to 3 visits shall be reserved and performed during installation to assist with any installation questions, inspect installation quality and verify manufacturer recommendations are followed.

a) Pipe Brazing Inspections: During each site visit, at the request of the manufacturer or representative of the manufacturer, the contractor shall cut up to three brazed sections of pipe per system to verify proper brazing techniques have been followed. If results of the inspection are unsatisfactory to the inspector, the entire refrigerant piping network shall be demolished and reinstalled at no additional cost to the owner.

b) Inspection Report: Issue a report for each site visit documenting name of person performing the site visit, date and time of visit and each issue that requires resolution with recommended corrective action.

2. Startup, Commissioning, and Owner training: Submit test reports.

3.05 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Section "Testing, Adjusting and Balancing for HVAC."

B. Verify actual evaporator applications and operating conditions and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

C. Adjust damper linkages for proper damper operation.

D. Adjust controls and safeties so equipment operates smoothly. Replace damaged or malfunctioning controls and equipment with new materials and products.

E. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

F. Protect installed products from moisture and water damage, physical damage and electrical damage during construction operations. Replace components that are broken or otherwise damaged beyond repair.

3.06 STARTUP

A. Final Checks before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Comb coil fins for parallel orientation.
5. Install clean filters. Do not operate air handling unit without pre-filters installed.
6. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.
8. Comply with manufacturer pre-installation checklists prior to start-up.

B. Start-Up Services: Engage a factory trained and authorized representative to start-up VRF system components in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment. Submit startup report.

C. Perform system testing, adjusting, and balancing. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Remove and replace malfunctioning units and retest as specified above.

3.07 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum time as specified below on the operation and maintenance of the equipment provided under this section.

1. Four hours.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

E. Submit training materials used during training for inclusion in the O&M manual for the project.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Package rooftop heating and cooling heat pump units.

B. Package rooftop heating and cooling dual fuel heat pump units.

1.02 SUBMITTALS

A. Product Data: Provide manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories.. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

C. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components

2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

D. Wiring Diagrams: Submit wiring diagrams detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling heat pump units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

E. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

F. Operation and Maintenance Data: Submit maintenance data and parts list for each heat pump unit, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Codes and Standards:

1. Gas-fired furnace section construction shall be in accordance with AGA safety standards. Furnace section shall bear the AGA label.

2. Test and rate rooftop heat pump units of 65,000 Btu/hr capacity or over in accordance with AHRI 340/360 “Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment”.

3. Test and rate rooftop heat pump units under 65,000 Btu/hr capacity in accordance with AHRI 210 “Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment” and provide Certified Rating Seal.

4. Test and rate sound performance of rooftop heat pump units in accordance with AHRI 270 “Sound Performance Rating of Outdoor Unitary Equipment”. Units shall bear Certified Rating Seal.

5. Comply with AHRI 1060 “Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment” for capacity ratings of air-to-air energy recovery equipment.

6. Construct refrigerating system of rooftop heat pump units in accordance with ASHRAE 15 “Safety Code for Mechanical Refrigeration”.

7. Equipment efficiencies for cooling and heating modes of rooftop heat pump units shall be equal to or greater than prescribed by ASHRAE 90.1 “Energy Standard For Buildings Except Low-Rise Residential Buildings”.

8. Rooftop heat pump units shall be listed by UL and have UL label as a unit.

9. Rooftop heat pump units shall be designed, manufactured, and tested in accordance with UL requirements. Comply with UL 1995 “Heating and Cooling Equipment”.

1.04 FLAMMABLE REFRIGERANTS

A. Equipment with refrigeration systems using Group A2L refrigerants shall meet all requirements of ASHRAE 15 and this section.

B. Listing and Installation Requirements:

1. Listed in accordance with UL 484 or UL 60335-2-40/CSA C22.2 No. 60335-2-40.

2. The nameplate shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing.

3. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing.

C. Refrigeration systems shall have an integral refrigerant detection system that meets the following requirements as documented in ASHRAE 15:

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.
2. Field recalibration of refrigerant detection system shall not be permitted.
3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.
4. Have access for replacement of refrigerant detection system components.
5. Have self-diagnostics to determine operational status of the sensing element.
6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.
7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, -1%).

D. Manufacturer’s refrigeration mitigation action shall be completed in not more than 15 seconds after the initiation of the output signal of the equipment’s integral refrigerant detection system and shall be maintained for at least 5 minutes after the output signal has reset.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept products, with factory-installed shipping skids and lifting lugs. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units. Inspect for damage.

B. Protect units from physical damage by storing off site or in locked, protected area until roof mounting curbs are in place, ready for immediate installation of units.

1.06 SPECIAL WARRANTY

A. Warranty on Compressor and Gas Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

1. Warranty Period: 5 years from date of substantial completion.

1.07 SPARE PARTS

A. Extra Materials: Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling heat pump unit:

1. One set of matched fan belts for each belt-driven fan.

2. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.

3. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Aaon, Inc.

B. Carrier Air Conditioning; Div. of Carrier Corp.

C. Daikin Applied.

D. Johnson Controls, Inc.

E. Trane (The) Co; Div. of American Standard Inc.

2.02 MANUFACTURED UNITS

A. General: Roof or slab mounted units, factory assembled, prewired and tested,

B. Description: Self-contained, packaged unit consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics shall be as scheduled on the Drawings.

C. Refrigerant: Provide rooftop units designed to operate with refrigerant as scheduled on the drawings.

2.03 FABRICATION

A. Cabinet: Provide manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a knockouts for electrical and piping connections, and an exterior condensate drain connection, and lifting lugs.

1. Bottom Duct Connections: Provide steel or aluminum walking grate on structural supports where connections are located in sections accessible by personnel for maintenance.

B. Insulation: Minimum of 1" thick, 1.5 pound density thermal insulation.

C. Condensate Drain Pan: Provide galvanized or stainless steel condensate drain pan sloped to drain connection.

D. Filters Section: Provide filter housing of material matching the unit casing with gasketed filter media holding frames. Provide access panel large enough for filter replacement with continuous gasketing and positive locking devices.

E. Roof Curbs: Refer to Section “Hangers and Supports for HVAC” for pre-engineered roof equipment supports and Section “Vibration Isolation for HVAC Piping and Equipment” for vibration isolated equipment support bases.

2.04 FANS

A. Supply Fans: Provide forward-curved or backward inclined, centrifugal fan wheel, V-belt drive with adjustable variable pitch motor pulley or direct drive, rubber isolated hinge mounted high efficiency motor and permanently lubricated motor bearings.

B. Condenser Fans: Provide propeller-type, direct-driven fans, resiliently mounted with fan guard with permanently lubricated bearings.

C. Power Exhaust Fan: Direct drive, propeller type designed for low tip speed. Motors shall be open drip-proof with internal motor protection and permanently lubricated ball bearings.

D. Variable Air Volume Control: Provide variable frequency drives to modulate fans to meet specified sequence of operation. Refer to Division 23 section “Variable Frequency Drives”.

2.05 MOTORS:

A. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

2.06 AIR FILTRATION

A. Pre-Filters Section: Provide 2" thick fiberglass throwaway pleated filters in filter rack, with maximum face velocity of 400 fpm and minimum MERV rating per ASHRAE 52.2 of MERV 13.

2.07 GAS-FIRED HEAT EXCHANGERS (DUAL FUEL UNITS):

A. Provide aluminized steel construction for gas-fired heat exchangers and burners with entering air temperatures higher than 50 F. Provide stainless steel construction for gas-fired heat exchangers and burners with entering air temperatures less than or equal to 50 F or have airstreams that are corrosive. Provide heat exchangers and burners designed for staged or

modulating operation as scheduled or noted on the drawings with minimum efficiency of 80 percent. Provide single gas connection.

B. Gas Burner: Atmospheric or power-vented type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.

C. Operating Controls: Provide the following controls for the gas-fired heat exchangers:

1. Intermittent pilot ignition;
2. Electronic spark ignition system;
3. High limit cutout;
4. Forced draft proving switch;
5. Flame roll-out switch.

2.08 ELECTRIC HEAT SECTIONS:

A. Provide manufacturer's standard construction electric heat coils, factory-wired for single point wiring connection, complete with control circuit transformer and fuse, airflow proving device, over-current and over-heat protection devices.

B. Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

2.09 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant.

C. Provide interlaced coils in multiple stage units to ensure full coverage over coil face.

D. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of refrigerant.

E. Provide corrosion protective coating where scheduled.

F. Provide 1 inch factory installed flexible elastomeric insulation around the suction and liquid lines not directly located above a condensate drain pan. If any piping is exposed to sunlight, provide UV protective coating.

2.10 COMPRESSORS:

A. Provide serviceable, semi-hermetic, or hermetic compressors with integral vibration isolators, and crankcase heaters which de-energize during compressor operation. Units shall also have:

1. Cylinder unloaders for capacity control, with minimum steps as scheduled.

B. Provide reversing valve, suction line accumulator, flow control check valve, and solid state defrost control utilizing thermistors.

C. Units shall have the following capacity control measures to prevent excessive compressor short cycling and prevent evaporator coil from freezing:

1. Digital scroll compressor as the first stage.

2. Inverter scroll compressor as the first stage.

D. Thermal expansion valves, filter dryers, sight glasses, compressor service valves, liquid line service valves; minimum of 2 refrigerant circuits for units having 2 or more compressors; and fan-cycling control for low ambient control to 25 deg F (2 deg C).

2.11 CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

B. Provide corrosion protective coating where scheduled.

C. Provide refrigerant pressure switches to cycle condenser fans.

2.12 MIXED AIR CASING

A. General: Dampers and their operators shall comply with performance requirements specified in Division 23 Section “Instrumentation and Control Devices for HVAC.”

B. Outdoor Air Damper:

1. Provide outside air damper constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven.

2. Refer to schedules and control diagrams on the drawings for quantity, capacity and control method of the outdoor air dampers of each unit.

C. Economizer Control:

1. Provide economizer system complete with return and outside air dampers, outside air filter, fully modulating electric control system with dry bulb or enthalpy control as noted on the drawings, and adjustable mixed-air thermostat.

2. System shall have 100 percent outside air capability.

3. Provide automatic changeover through adjustable control device.

D. Relief Damper: Provide a relief damper with control type as scheduled on the drawings.

2.13 OPERATING CONTROLS:

A. Provide solid-state control board and components that contain at a minimum the following features in addition to control features specified in the contract documents:

1. Indoor fan on/off delay.
2. Default control to ensure proper operation after power interruption.
3. Service relay output.
4. Unit diagnostics and diagnostic code storage.
5. Field-adjustable control parameters.
6. Minimum run time.
7. Return-air temperature limit.
8. Fan-proving switch to lock out unit if fan fails.

B. DDC Interface: Install stand-alone control module providing link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 section "Direct Digital Control for HVAC".

C. Thermostat: Programmable, electronic; with heating setback and cooling setup with seven-day programming; and the following:

1. Touch sensitive keyboard.
2. Automatic switching.
3. Degree F readout.
4. LED indicators.
5. Hour/day programming.
6. Manual override capability.
7. Time and operational mode readout.
8. Status indicator.
9. Battery backup.
10. Subbase with manual system switch (on-heat-auto-cool) and fan switch (auto-on).

2.14 SAFETY CONTROLS:

A. Provide the following:

1. Low pressure cutout, manual reset;
2. High pressure cutout, manual reset;
3. Compressor motor overload protection, manual reset;
4. Anti-recycling timing device;
5. Adjustable low-ambient lockout;
6. Oil pressure switch.

2.15 ELECTRICAL

A. Provide a 125 VAC, 20 amp duplex convenience receptacle mounted to unit ready for field wiring through the curb with a cover UL listed for wet and damp locations when in use.

B. Unit power connection shall be either through unit cabinet or within roof curb perimeter.

C. Rooftop heat pump units shall be designed to meet the minimum short-circuit withstand rating specified on the drawings.

2.16 ENERGY RECOVERY SECTION

A. General: Provide a factory mounted, wired, and tested energy recovery wheel. The energy recovery wheel shall have latent and sensible recovery capacities as required to meet or exceed the capacities scheduled on the drawings.

1. Mount the energy recovery wheel in a rigid frame containing the wheel drive motor, redundant drive belts, wheel seals, and bearings.
2. Provide an energy recovery wheel constructed of a light-weight polymer material with permanently bonded desiccant coating. The wheel shall be removable from the cabinet and cleanable using hot water or light detergent without degrading the latent efficiency.
3. Provide a forward curved exhaust fan(s) with adjustable V-belt drive and a backdraft damper.
4. Provide a filter bank on the upstream side of each air stream with 2" thick fiberglass throwaway filters in filter rack, with maximum face velocity of 400 fpm and minimum MERV rating per ASHRAE 52.2 of MERV 8.

B. The energy recovery section shall contain bypass dampers around the wheel for full economizer operation.

C. Frost Protection: Provide heat or wheel speed control to eliminate frost accumulation.

2.17 ACCESSORIES:

A. Units shall include the following accessories where scheduled or shown on the drawings:

1. Anti-recycling control to automatically prevent compressor restart for 5-minutes after shutdown.

2. Low ambient control head pressure control, designed to operate at temperatures down to temperatures indicated in schedule on the drawings.

3. Provide guards to protect the condenser coil from hail or other damage.

4. Provide birdscreens on outside air inlets to units.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas and conditions under which rooftop units are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. For roof installed units, verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

D. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF ROOFTOP HEATING AND COOLING HEAT PUMP UNITS

A. General: Install units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Secure roof-mounted units to roof equipment supports and grade-mounted units to curbs or base. Refer to the drawings for the type of support required for each rooftop unit.

1. Refer to Section “Hangers and Supports for HVAC Piping and Equipment” for standard roof curbs.

2. Refer to Section “Vibration Isolation For HVAC” for vibration isolation curbs.

C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26

sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

D. Ductwork: Refer to Division-23 section "Metal Ducts". Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

E. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Condensate Drain Piping: Route condensate drain to nearest roof drain or to location shown on the drawings. Provide trap at connection to drain pan with depth as noted on the drawings and install cleanouts at changes in direction (refer to manufacturer's recommendations for any additional requirements). Size condensate drain piping in accordance with local code and as shown on the drawings.

F. Connect condensate drain piping to the unit with appropriate trap. Verify that the piping material and installation is in accordance with Division 22 requirements.

G. Connect gas piping to gas-fired heat exchanger according to requirements of Division 22 section "Natural Gas Systems." Provide union with sufficient clearance for burner removal and service.

3.03 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Section "Testing, Adjusting and Balancing for HVAC." Tighten belts as required for proper operation.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.04 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Set outside-air and return-air mixing dampers to minimum outside-air setting.

7. Comb coil fins for parallel orientation.

8. Install clean filters. Do not operate air handling unit without pre-filters installed.

9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

10. Disable automatic temperature control operators.

B. Start-Up Services: Provide the services of a factory-authorized service representative to start-up rooftop heat pump units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a) Replace fan and motor pulleys as required to achieve design conditions.

b) Measure and record motor electrical values for voltage and amperage.

c) Shut unit down and reconnect automatic temperature control operators.

d) Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

3.05 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Cabinet Unit Heaters

1.02 SUBMITTALS

A. Submit Shop Drawings as required by Division 1.

B. Submit product data for each type and size of electric heater.

C. Shop Drawings shall indicate volts, phase, watts and all options that are to be provided.

D. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

E. Shop Drawings showing fabrication and installation of electric resistance heating units including plans, elevations, sections, details of components, and attachments to other units of Work.

F. Color Samples: Submit color samples for each type of cabinet finish furnished for Architect selection.

G. Maintenance data for electric resistance heaters to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions for cleaning.

1.03 REGULATORY REQUIREMENTS

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing radiant heating panels similar to those indicated for this Project and that have a record of successful in-service performance.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70 "National Electrical Code", Article 100.

   a) Comply with NFPA 70 for components and installation.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

3. Fire-resistance-rated, gypsum board assemblies are identical to design designations in listing and labeling agency's product directory.

C. Provide products listed and classified by Underwriter's Laboratories, Inc. as suitable for purpose intended. Comply with UL 1995 "Heating and Cooling Equipment".

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide electric heaters of voltage, size and capacity as indicated on the Drawings.

B. Electric heaters shall be designed for a single circuit supply and provided with a single integral, factory-mounted power disconnect switch. Heating elements, motor and control circuits shall be subdivided and fused.

C. Elements shall consist of helically coiled nickel chromium alloy resistance wire embedded and completely surrounded in magnesium oxide, enclosed in corrosion resistant sheaths and permanently attached to corrosion resistant steel fins.

D. Motors shall be totally enclosed industrial type, permanently lubricated and equipped with thermal overload protection with automatic reset. Motors shall be mounted on a heavy gauge formed metal bracket. After the thermostat has been satisfied, the fan shall continue to run until residual heat has been dissipated.

E. Electric heaters shall be equipped with an automatic reset thermal cutout which disconnects elements and motors in the event normal operating temperatures are exceeded.

F. Contactors, relays and control transformers shall be factory assembled and wired.

G. Provide 24 volt factory wired thermostat.

2.02 CABINET UNIT HEATERS

A. Manufacturers:

1. King Electric
2. Markel
3. Q Mark

B. Provide multi-speed, permanent split capacitor type centrifugal fan motor with external or internal overload protection. Furnish magnetic motor starter and step-down transformer for 115 volt motor control circuit.

C. Construct cabinets of minimum 18 gauge furniture steel, baked enamel finish, with color as selected by the Architect. Filtered air inlet and outlet openings shall be substantially formed grilles. Cabinets for recessed units shall completely overlap all sides of the wall openings. Refer to Architectural Drawings for recess

depth available. Mount recessed units with the bottom 6" above finished floor line.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify conditions are acceptable prior to beginning installation.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Locate each unit in the position indicated.

C. Install units with sufficient clearance from adjacent construction, piping, ductwork and other obstructions to allow access for service and maintenance.

D. Support unit heaters from structure.

E. Install flush units tight to the wall. The unit trim shall cover the opening.

3.03 FIELD QUALITY CONTROL

A. Verify operation of each electric heating unit by measuring input voltage and current simultaneously for period of ten minutes of continuous operation.

3.04 DEMONSTRATION

A. Demonstrate location and setting procedures for thermostats and other heating controls.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and to all following sections within Division 26.

1.02 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 26 of these Specifications, and Drawings numbered with prefixes E and ME, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.03 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."

2. Install: “To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use.”

3. Provide: “To furnish and install complete, and ready for the intended use.”

4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division.

6. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is the "Architect".

7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.

9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a) Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b) Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified

B. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

C. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

D. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

3. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.

E. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Sub-base: as used in this section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.

3. Sub-grade: as used in this section refers to the compacted soil immediately below the slab or pavement system.

4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.04 REFERENCE STANDARDS

A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and

municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

1. IBC International Building Code
2. ADA Americans with Disabilities Act
3. AEIC Association of Edison Illuminating Companies
4. ANSI American National Standards Institute
5. ASTM American Society of Testing Materials
6. AWS American Welding Society
7. AWWA American Water Works Association
8. ICEA Insulated Conductors Engineers Association
9. IEEE Institute of Electrical and Electronics Engineers
10. IES Illuminating Engineering Society
11. NBFU National Board of Fire Underwriters
12. NEC National Electrical Code, NFPA 70
13. NECA National Electrical Contractors Association
14. NEMA National Electrical Manufactures' Association
15. NETA InterNational Electrical Testing Association
16. NFPA National Fire Protection Association

17. OSHA Occupational Safety and Health Act

18. UL Underwriter's Laboratories

E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.

G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.

C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.

D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste

G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.06 MEASUREMENTS AND LAYOUTS

A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.08 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper

submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified . Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or time specified in Engineer's Agreement with the Client, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.

1.09 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:
    a) Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

b) Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

c) Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.

d) Same warranty will be furnished for proposed substitution as for specified Work.

e) If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f) Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.

a) If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.

4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. Contact the Contract Administrator for written authorization.

D. The following must be received before electronic drawing files will be sent:

1. Contract Administrator's written authorization
2. Engineer’s release agreement form
3. Payment

1.11 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures, and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish the Operation and Maintenance Manuals to the Contract Administrator, for Engineer’s review, and for the Owner’s use.

1. Refer to Division 01 for acceptance of electronic manuals for this project. If not specified in Division 1, provide manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and

equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

a) Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

2. If Division 01 requires paper manuals, provide four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings.

3. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

1.13 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division

1.14 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer’s standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. Also warrant the following additional items:

1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
2. All raceway seals are effective.
3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.

E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending

beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

a) Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.

b) If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 PERMITS

A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.03 TEMPORARY ELECTRICAL SERVICE AND WIRING

A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.

B. In existing facilities, with Owner's approval, Contractor may utilize the existing electrical system as the source of temporary power. Coordinate the point of connection and method of connection to the existing system with the Owner's Representative.

C. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.

D. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.

E. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

F. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.

G. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).

H. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.

I. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.

J. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.

K. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.04 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".

B. Maintain all code required clearances, equipment access widths, and clearances required by manufacturers.

3.05 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".

B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.06 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.

C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.

D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.

E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be

responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

F. Slope sides of excavations to comply with local, state, and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state, and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.

2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.

5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas use excavated or borrowed materials.

O. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not

more than 4 inches in loose depth for material compacted by hand-operated tampers.

1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less that 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.

Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

   a) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   b) Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   c) Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.07 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.08 PAINTING

A. Refer to Division 09 Section “Painting” for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer’s instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly

damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.09 CLEANING

A. Refer to Division 01 for Sustainability Requirements for cleaning procedures in accordance with LEED, in addition to requirements specified herein.

B. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

C. Immediately prior to the final inspection, the Electrical Contractor shall clean material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment.

D. Damaged finishes shall be touched-up and restored to their original condition

3.10 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.

B. Check motors for alignment with drive and proper rotation, and adjust as required.

C. Check and test protective devices for specified and required application, and adjust as required.

D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.

E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.

G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.

H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.

J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.

K. Refer to individual sections for additional and specific requirements.

3.11 START-UP OF SYSTEMS

A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.

B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.

C. Adjust taps on each transformer for rated secondary voltages.

D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent between all phases, with all designed loads in operation.

E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.

F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.

G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.12 TEST REPORTS

A. Perform tests as required by these Specifications and submit the results to the Contract Administrator, for Engineer's review. Record the results, date and time of each test and the conditions under which the test was conducted. Include a copy of the finalized test results, with corrections made, in the Operations and Maintenance Manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.

B. For specific testing requirements of special systems, refer to the Specification section that describes that system. The Contractor shall provide the following to facilitate the testing of the electrical systems:

1. Perform tests as described in the individual sections;
2. Engage the services of a 3rd Party testing agency to perform tests as noted below, or;
    a) Agent may be an employee of the contractor but shall be NETA certified to perform electrical testing.

C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:

1. Building service entrance voltage and amperes at each phase.
2. Electrical service grounding conditions and grounding resistance.
3. Proper phasing throughout the entire system.
4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
5. Phase voltages and amperes at each three-phase motor.
6. Test all wiring devices for electrical continuity and proper polarity of connections.

D. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

3.13 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit complete Operation and Maintenance Data.
2. Submit complete Record Drawings.
3. Perform all required training of Owner's personnel.
4. Turn over video recordings of training sessions to the Owner.
5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
6. Perform start-up tests of all systems.
7. Remove all temporary facilities from the site.
8. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION

26 0123 - LIGHTING

EQUIPMENT

MANUFACTURER	Artemide
CATALOG NUMBER	T4600510
TOTAL WATTS	75
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	
FINISH	WHITE
RATING	IP65
LISTING	

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	95+
LUMEN OUTPUT	960
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

Surface mount specialty light with one (1) LED lighting source, 960 delivered lumens, 3000K color engine, 95+ CRI, 360° optic and remote driver. Light should operate on 120 voltage and be supplied with a dali control option. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Light to have white finish. Light to be rated for IP65 or equivalent.

CONTROL

PROTOCOL	DALI
INTENT	

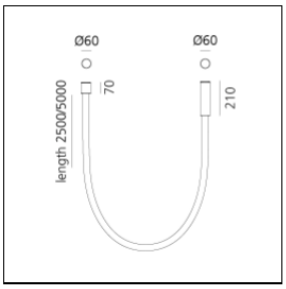
NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

La linea - 5mt - SMD

BIG - Bjarke Ingels Group

IP65



LUMINAIRE

- Watt: **15W/m**
- Delivered lumen output: **960 lm/m**
- CCT: **3000K**
- Efficiency: **100%**
- Efficacy: **64lm/W**
- CRI: **95**

Notes

10 wall/ceiling supports included
Weight 1.4 kg/m
Driver included

DESCRIPTION

La Linea is a flexible light tube capable of freely rotating in space, creating indefinite geometries. It seamlessly integrates into both indoor and outdoor spaces thanks to fastening elements that disappear within the cross-section, allowing for countless applications across a wide range of settings. Its unique combination of light quality, IP protection rating, and flexibility makes it a versatile lighting solution. Available in 2.5 and 5-meter lengths.
Backbone is a fully custom aluminum structure that supports La Linea, ensuring stability and a well-defined shape. This solution allows the modules to be suspended, enabling the creation of linear or curved compositions tailored to specific needs.

FEATURES

- Product Code: **T4600510**
- Colour: **White**
- Installation: **Ceiling, Wall**
- Material: **High diffusion optical silicone lamp body. Transparent technopolymer wall mounts. Steel recessed ceiling mounts, steel and aluminum surface-mounted ceiling mounts.**
- Series: **Design Collection, Architectural Outdoor**
- design by: **BIG - Bjarke Ingels Group**

DIMENSIONS

- Length: **5000 mm**
- Diameter: **40 mm**

We reserve the right to change our product specifications. — Last update: April 2025
Please visit www.artemide.com for the latest product information

Artemide

Accessories

Additional wall/ceiling mount for outdoor use (5 pcs) R304975

We reserve the right to change our product specifications. — Last update: April 2025
Please visit www.artemide.com for the latest product information

Artemide

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	ICO2STRC 30/20 AR-LSS-35D-MVOT-UGZ-SGBCC-DBL
TOTAL WATTS	28.6
VOLTAGE	120/277
MOUNTING	Surface
WEIGHT	
DIMENSIONS	
FINISH	Black
RATING	IP
LISTING	

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2000
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	
PROVIDED BY	

ACCESSORIES

Surface mount adjustable cylinder with one (1) LED lighting source, 2000 delivered lumens, 3000K color engine, 80+ CRI, 35° optic. Cylinder should operate on 120/277 voltage and be supplied with a 0-10v control option down to 1% with a 50,000 hour anticipated life. Cylinder to have black finish.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

gotham® | INCITO™

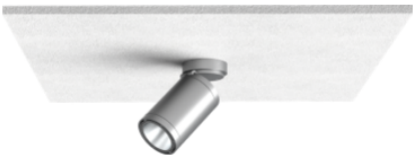
Multiple Layers of Light

Luminaire Type:

Catalog Number:

Buy American

High Center Beam Tilt/Rotate Surface Ceiling Cylinder 2"

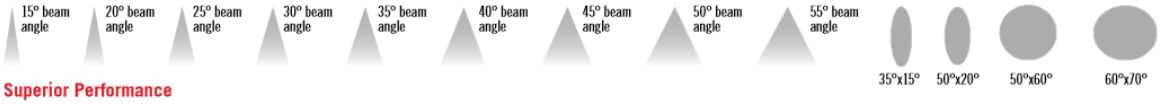


OVERVIEW

Feature Set

- Adjustable tilt (90°) and rotation (365°)
- Thirteen optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 50° Cutoff to source and source image
- Field interchangeable optic
- Surface mounted or recessed mounted driver options
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling (WL option) available
- ENERGY STAR® Certified product
- 20 standard colors in textured and gloss finish; custom & RAL colors also available

Distribution



Superior Performance

Nominal lumens	250	500	750	1000	1500	2000
Delivered	263	560	859	1177	1764	2227
Wattage	3.1	5.6	8.7	12.0	19.8	28.6
Efficacy	85	100	99	98	89	78

*Based on 3500K 80CRI 15D AR LSS

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Healthcare

Special Applications

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham® | INCITO™

2" High Center Beam Tilt/Rotate Surface Ceiling Cylinder

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Luminaire Type:

Catalog Number:

EXAMPLE: IC02STRC 35/10 AR LSS 20D MVOLT UGZ RGH DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Beam	
IC02STRC	Incito 2in Round Surface Ceiling Tilt/ Rotate Cylinder Open Downlight	27/	2700 K	02	250 lumens	AR	Clear	LSS	Semi-specular	15D	15° beam angle
		30/	3000 K	05	500 lumens	PR	Pewter	LD	Matte diffuse	20D	20° beam angle
		35/	3500 K	07	750 lumens	WTR	Wheat			25D	25° beam angle
		40/	4000 K	10	1000 lumens	GR	Gold			30D	30° beam angle
		50/[1]	5000 K	15	1500 lumens	WR[2]	White painted			35D	35° beam angle
				20	2000 lumens	BR[2]	Black painted			40D	40° beam angle
						BZR[2]	Dark Bronze painted			45D	45° beam angle
										50D	50° beam angle
										55D	55° beam angle
										3515D	Elliptical 35° x 15° beam angle
										5020D	Elliptical 50° x 20° beam angle
										5060D	Elliptical 50° x 60° beam angle
										6070D	Elliptical 60° x 70° beam angle

Voltage		Driver		Mounting		Control Interface[5]	
MVOLT	120V - 277V	UGZ[3]	Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	RGH[4]	Recessed Gear Housing	(blank)	
120	120V			SGB	Surface Gear Box	NLT	nLight® dimming pack.
277	277V			SGBPR	Surface Gear Box with Concealed Plaster Ring	NLTER[6]	nLight® dimming pack for fixtures on emergency circuit
				SGBCC	Direct Conduit Surface Gear Box	NLTAIR2	nLight® AIR dimming pack.
				JBXCC	Surface J-Box with Conduit Covers	NLTAIRER2[6]	nLight® AIR dimming pack for fixtures on emergency circuit
						NLTAIREM2	nLight® AIR dimming pack for fixtures on emergency circuit

Options		Architectural Colors - Powder Paint[9]			
90CRI[1]	High CRI (90+)	DDB	Gloss Dark Bronze	DDBT	Textured Dark Bronze
N80[7]	nLight Lumen Compensation	DBL	Matte Black	DBLB	Textured Black
WL[8]	Wet Location	DWH	Gloss White	DWHG	Textured White
		DMB	Matte Medium Bronze	DBNH	Textured Bronze
		DNA	Gloss Natural Aluminum	DNAT	Textured Natural Aluminum
		DSS	Gloss Sandstone	DSST	Textured Sandstone
		DGC	Gloss Charcoal Grey	DSPD	Textured Dark Grey
		DTG	Gloss Tennis Green	DSPE	Textured Green
		DBR	Gloss Bright Red	DSPH	Textured Light Red
		DSB	Gloss Steel Blue	DWHAMF	Gloss White with Anti-microbial finish

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes.
IC020PTC XXD	Additional optics for field installation. Replace "XX" with beam angle.
IC020PTC KIT	Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns
HS234FL	Hole saw for RGH option
SDT 347/120 75VA	347V/120V, 75VA step down transformer. Must be remote mounted.

ORDERING NOTES

1. 5000K CCT not available with 90CRI.
2. Not available with Reflector Finish.
3. Refer to Tech 240 for compatible dimmers.
4. RGH with 2000LM option requires 120 or 277 (non-IC).
5. Field installed. Access required to location of remote mounted device.
6. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
7. Requires NLT or NLTER.
8. Not available with SGBCC or JBXCC.
9. For details on RAL and Custom colors please see Architectural colors.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham®

SPECIFICATIONS

Optical and Trim Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 50° cutoff to source and source image. Top down flash characteristic for superior glare control.

Superior 100% Virgin-silicone refractive optic, enables maximum dimensional stability and optical transmission with no discoloration over life. Field inter-changeable optics.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages. THD @ Full Load is >20%. Inrush current meets NEMA-410 requirments. Surge Protection +/- 1kV DM, +/- 2kV CM.

Controls

Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 1.0% of rated lumen output with a smooth shut off function to step to 0%.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Surface Gear Box (SGB) for direct installation to 4" recessed or surface octagonal (by others).

Recessed Gear Housing (RGH) ships with driver box for recessed or surface installation.

Die cast with flangeless reflector allows flow-through passive thermal management.

Accommodates between 3/8" to 3"-thick ceilings.

Listings

Fixtures are UL Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location covered ceiling optional (WL).

RGH option is IC rated up to 1500LM

Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed

Buy American

This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FARS, DFARS and DOT. Please refer to https://www.acuitybrands.com/resources/buy-american for additional information.

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Warranty

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.910
	3000K	0.946
	3500K	1.000
	4000K	1.027
	5000K	1.054
90	2700K	0.784
	3000K	0.847
	3500K	0.874
	4000K	0.946

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LSS - Semi Specular	1.00
LD - Matte Diffuse	0.98
Reflector Color	**Multiplier**
WR - White	0.98
BR - Black	0.92
BZR - Bronze	0.91
AR - Clear	1.00
GR - Gold	0.99
PR - Pewter	0.99
WTR - Wheat	0.98

Driver		Control Provided				
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIREM2	NLTAIRER2
UGZ	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations	
		SGB	RGH
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep (by others)	✓	✗
	4" Octagonal 4x4x2.125 deep (by others)	✓	✗
	Factory Provided Gear Box (4" Square 4x4x1.5 deep)	✗	✓

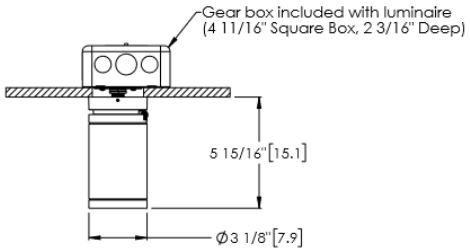
Standard Architectural Color Options for Cylinder Bodies

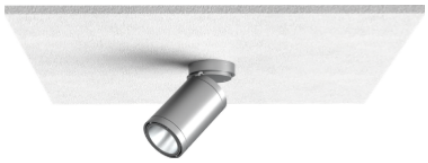
NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please always contact a Gotham representative for an accurate paint chip sample.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

DIMENSIONAL DATA

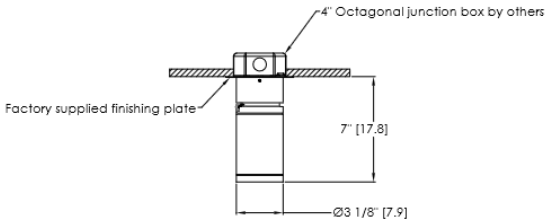
RGH - Recessed Gear Housing



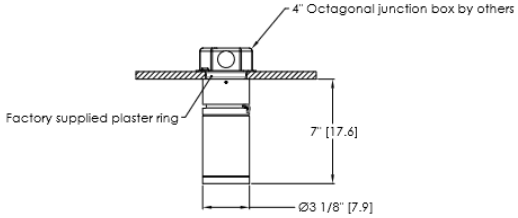


Ceiling cutout: Ø2 3/4" [7]
Ceiling thickness range: 3/8" [1.0] to 3" [7.6]

SGB - Surface Gear Box



SGBPR - Surface Gear Box with Plaster Ring



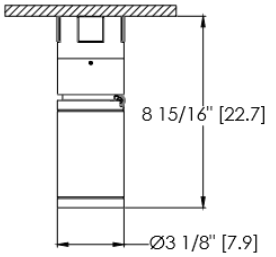
*Dimensions in inches [centimeters]

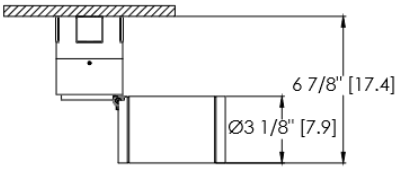
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham

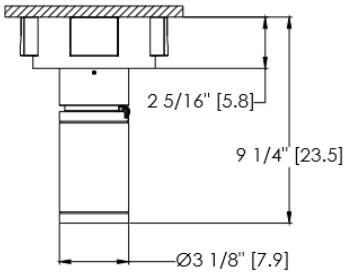
DIMENSIONAL DATA

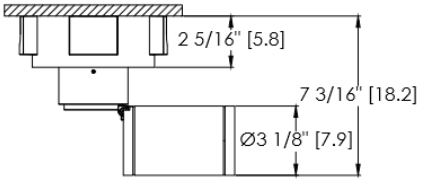
SGBCC - Direct Conduit Surface Gear Box

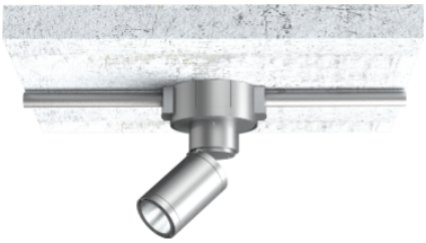




JBXCC - Surface J-Box with Conduit Covers







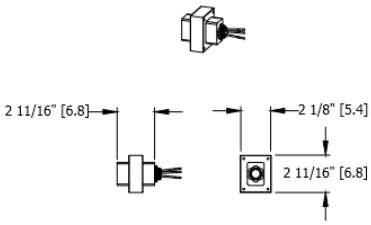
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham

DIMENSIONAL DATA

347V Transformer



347 Transformer:
Install to accessible
junction box by others

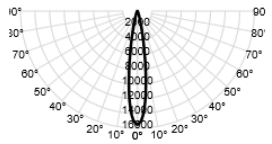
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY

ICO2STRC 35/15 AR LSS 15D Input Watts: 19.8, Delivered Lumens: 1764, LPW: 89.1, S/MH: 0.28, Test No: 19-383-01P713

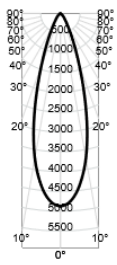


CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	15,477	0° - 30°	1,650	94%	
5°	12,289	0° - 40°	1,721	98%	
15°	1,789	0° - 60°	1,761	100%	
25°	320	0° - 90°	1,764	100%	
35°	113	90° - 180°	0	0%	
45°	41	0° - 180°	1,764	100%	
55°	8				
65°	2				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	113	112	110	111	110	108	107	106	105	
2	109	106	104	107	105	103	104	102	100	
3	105	101	99	103	100	98	101	99	97	
4	101	98	95	100	97	94	98	96	93	
5	98	94	92	97	94	91	96	93	91	
6	95	92	89	95	91	89	94	91	88	
7	93	89	87	92	89	87	91	88	86	
8	91	87	85	90	87	85	90	86	84	
9	89	85	83	88	85	83	88	85	83	
10	87	84	81	87	83	81	86	83	81	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	429.9	1.7	0°	5,875,626
8.0	241.8	2.3	45°	22,013
10.0	154.8	2.9	55°	4,964
12.0	107.5	3.5	65°	1,886
14.0	79.0	4.1	75°	1,027
Beam Angle: 16.6°			85°	871
Field Angle: 31.5°				

ICO2STRC 35/15 AR LSS 30D Input Watts: 19.8, Delivered Lumens: 1679, LPW: 84.8, S/MH: 0.51, Test No: 19-383-04P713

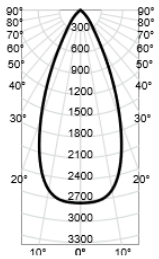


CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	4,876	0° - 30°	1,439	86%	
5°	4,562	0° - 40°	1,588	95%	
15°	2,498	0° - 60°	1,674	100%	
25°	742	0° - 90°	1,679	100%	
35°	228	90° - 180°	0	0%	
45°	91	0° - 180°	1,679	100%	
55°	15				
65°	4				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	112	110	108	110	108	106	106	104	103	
2	106	102	99	104	101	98	101	98	96	
3	100	96	93	99	95	92	96	93	90	
4	95	91	87	94	90	87	92	88	86	
5	91	86	82	90	85	82	88	84	81	
6	87	82	78	86	81	78	85	80	77	
7	83	78	75	82	78	74	81	77	74	
8	80	75	71	79	74	71	78	74	71	
9	77	72	68	76	72	68	75	71	68	
10	74	69	66	73	69	66	73	68	66	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	135.4	3.3	0°	1,850,977
8.0	76.2	4.4	45°	48,643
10.0	48.8	5.5	55°	9,862
12.0	33.9	6.5	65°	3,234
14.0	24.9	7.6	75°	1,614
Beam Angle: 30.5°			85°	871
Field Angle: 56.8°				

ICO2STRC 35/15 AR LSS 45D Input Watts: 19.8, Delivered Lumens: 1662, LPW: 83.9, S/MH: 0.72, Test No: 19-383-07P713

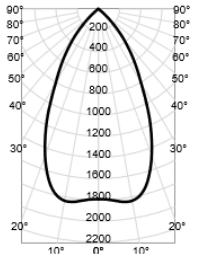


CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	2,739	0° - 30°	1,337	80%	
5°	2,721	0° - 40°	1,548	93%	
15°	2,216	0° - 60°	1,657	100%	
25°	1,047	0° - 90°	1,662	100%	
35°	322	90° - 180°	0	0%	
45°	116	0° - 180°	1,662	100%	
55°	16				
65°	4				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	111	109	107	109	107	105	105	104	102	
2	104	101	98	103	99	96	99	97	94	
3	98	94	90	97	93	89	94	91	88	
4	92	87	83	91	87	83	89	85	82	
5	87	82	78	86	81	78	85	80	77	
6	83	77	73	82	77	73	80	76	73	
7	78	73	69	78	73	69	77	72	69	
8	75	69	65	74	69	65	73	68	65	
9	71	66	62	71	65	62	70	65	62	
10	68	63	59	67	62	59	67	62	59	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	76.1	4.9	0°	1,039,647
8.0	42.8	6.5	45°	62,226
10.0	27.4	8.2	55°	10,789
12.0	19.0	9.8	65°	3,414
14.0	14.0	11.4	75°	1,760
Beam Angle: 44.4°			85°	1,307
Field Angle: 73.4°				

ICO2STRC 35/15 AR LSS 55D Input Watts: 19.8, Delivered Lumens: 1697, LPW: 85.7, S/MH: 0.90, Test No: 19-383-09P713



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	1,793	0° - 30°	1,168	69%	
5°	1,815	0° - 40°	1,528	90%	
15°	1,730	0° - 60°	1,692	100%	
25°	1,144	0° - 90°	1,697	100%	
35°	574	90° - 180°	0	0%	
45°	190	0° - 180°	1,697	100%	
55°	13				
65°	4				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	111	108	106	109	106	104	104	103	101	
2	103	99	95	101	97	94	98	95	92	
3	96	91	87	94	90	86	92	88	85	
4	89	84	80	88	83	79	86	82	78	
5	84	78	73	83	77	73	81	76	72	
6	78	72	68	78	72	68	76	71	67	
7	74	67	63	73	67	63	72	66	63	
8	69	63	59	69	63	59	68	62	59	
9	65	59	55	65	59	55	64	59	55	
10	62	56	52	61	56	52	60	55	52	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	49.8	6.4	0°	680,772
8.0	28.0	8.6	45°	102,010
10.0	17.9	10.7	55°	8,803
12.0	12.5	12.9	65°	3,144
14.0	9.1	15.0	75°	1,760
Beam Angle: 56.5°			85°	1,307
Field Angle: 90.4°				

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham

NLIGHT AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories

Order as separate catalog number. Visit nLight AIR.

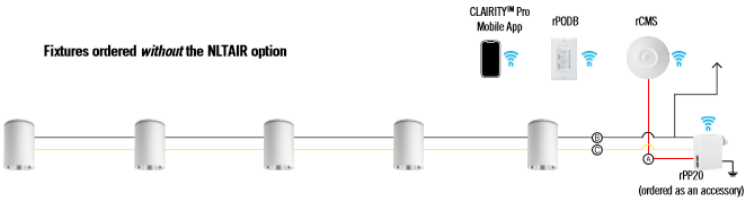
Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

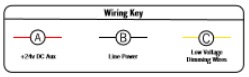
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option



Fixtures ordered *with* the NLTAIR option



NLIGHT

nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories

Order as separate catalog number. Visit nLight.

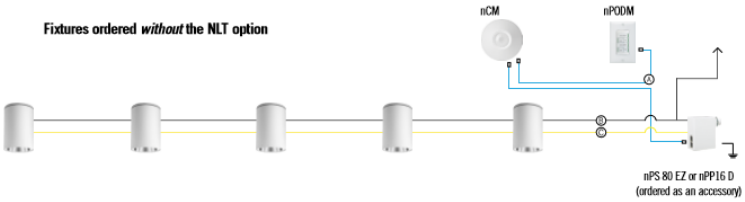
Wall Switches	Model Number
On/Off single pole	nPODM (XX)
On/Off two pole	nPODM 2P (XX)
On/Off & raise/lower single pole	nPOD DX (XX)
On/Off & raise/lower two pole	nPODM 2P DX (XX)
Graphic touchscreen	nPOD GFX (XX)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

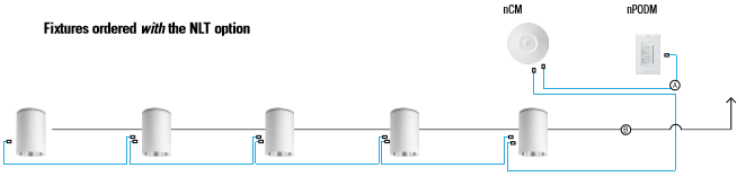
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

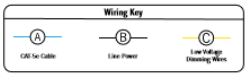
Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option





GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham®

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	IVO4CYL SC D 25LM 30K 80CRI 40D DARK MVOLT EZT L9 JBX P AR LS DBL
TOTAL WATTS	28.6
VOLTAGE	120/277
MOUNTING	Surface
WEIGHT	
DIMENSIONS	9-13/16" x 5-1/2" x 5-1/2"
FINISH	Black
RATING	IP
LISTING	

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2447
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES

Surface mount adjustable cylinder with one (1) LED lighting source, 2447 delivered lumens, 3000K color engine, 80+ CRI, 40° optic. Cylinder should operate on 120/277 voltage and be supplied with a 0-10v control option down to 1% with a 55,000 hour anticipated life. Cylinder to have black finish.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

gotham | IVO™

Luminaire Type: **A66**

Catalog Number: **IVO4CYL SC D 25LM 30K 80CRI 40D DARK MVOLT EZT L9 JBX P AR LS DBL**

IVO™ 4" Round Cylinders
Surface Mount

ø5.5" x 9-13/16"

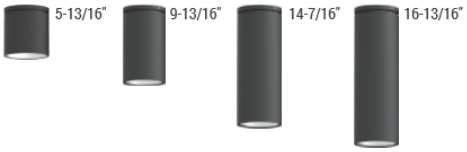
MOUNTING STYLES AND TRIM COLORS

Surface Mount with Recessed J-box (JBX)

Surface Mount with Surface J-box (JBX)

Conduit Cover Surface Mount with Surface J-box (JBXCC)

Cylinder Lengths

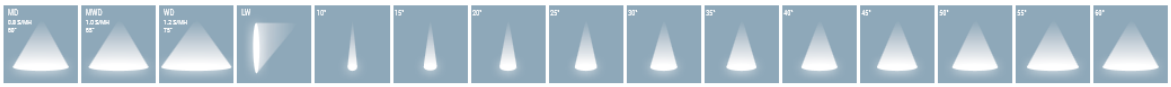


QUICK SPECIFICATIONS

Feature Set

- Perfect Color™ consistency within 1/2-step MacAdam Ellipse
- 45° visual cut-off angle to source (65° cut-off for L5 length)
- Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare
- Available with 10%, 1%, or 0.1% dim to dark
- Downlight and Wall Wash trims are interchangeable
- 90% lumen maintenance at 55,000 hours
- Clean beams with soft transitions
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture
- Exceptional color with 80 CRI, 90 CRI, or 95 CRI min
- Field changeable optics available every 5°
- Wet Location optional, covered ceiling

Distribution / Beam Angles



Superior Perfomance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	493	735	991	1486	1968	2447	2732	3313	3796	4236
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	96	100	101	99	96	91	92	96	91	94

*Based on Downlight performance: 3500K 80CRI MWD P AR LSS, for L9, L14, and L16. See Photometry section for Wall Wash performance. See IES files available online for L5 performance.

PRODUCT FAMILY

IVO 4" Round Product Family

Downlight | Lensed WW | Surface Cylinder | Pendant Cylinder | Wall Cylinder | Wall Adjustable Cylinder

NOM RoHS COMPLIANT WET LOCATION™ LOW DDE nLIGHT

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

Luminaire Type: **A66**

Catalog Number: **IVO4CYL SC D 25LM 30K 80CRI 40D DARK MVOLT EZT L9 JBX P AR LS DBL**

EXAMPLE: IVO4CYL SC D 20LM 35K 80CRI MWD MIN10 MVOLT EZT L5 JBX P AR LD DWH

ORDERING INFORMATION

Series	Mounting Option	Function	Lumen Packages	Kelvin Temperature	Color Rendering Index
IVO4CYL IVO 4" Round Cylinder	SC Surface Mount Cylinder	D Downlight WW Wall Wash	05LM[1] 500 Lumens 07LM 750 Lumens 10LM 1000 Lumens 15LM 1500 Lumens 20LM 2000 Lumens 25LM 2500 Lumens 30LM 3000 Lumens 35LM 3500 Lumens 40LM 4000 Lumens 45LM 4500 Lumens	27K 2700K 30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80+ CRI 90CRI[2] 90+ CRI, R9 50+ 95CRI[2] 95+ CRI, R9 80+

Distribution[3]	Dimming Level	Voltage	Control Input[6]
Narrow / Flood[4] 10D 10°, 30D 30°, 50D 50° 15D 15°, 35D 35°, 55D 55° 20D 20°, 40D 40°, 60D 60° 25D 25°, 45D 45° General Illumination / Batwing MD Medium Batwing (0.8 s/mh, 60°) MWD Medium Batwing Wide (1.0 s/mh, 65°) WD Wide Batwing (1.2 s/mh, 75°)	MIN10 Min 10% Dim Level MIN1 Min 1% Dim Level DARK Min 0.1% Dim Level, Dim-to-Dark	MVOLT Multi-Volt Input, 120V-277V 120 120V Input 277 277V Input 347[5] 347V Input	ZT[7] Generic 0-10V ELV[8] Phase Dimming (Forward/Reverse) (120V only) EZT EldoLED 0-10V DALI[9] DALI-2 DMX[9,10] DMX NLIGHT[11] Wired controls by nLight NLTAIR2[11] Wireless controls by nLight NLIGHTER[11] Wired controls by nLight with UL924 listed emergency operation NLTAIREM2[11] Wireless controls by nLight with UL924 listed emergency operation

Cylinder Length	Mounting Style	Fusing	Emergency Pack[13]	Wet/IP Listing
L5[12] Shallow 5-13/16" Cylinder L9 Standard 9-13/16" Cylinder L14 Long 14-7/16" Cylinder L16 Extra Long 16-13/16" Cylinder	JBX Integral driver, Recessed or Surface J-box JBXCC Integral driver, Surface J-box with conduit covers	(blank) No Options SF Single Fuse, specify 120V or 277V	(blank) No Emergency Pack E7W[14] Emergency battery pack, Constant Power, Title 20 compliant, user selectable Self-Diagnostics, AC Activate with Integral Test Switch. E7WR 7W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) E10WR 10W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) E15WR 15W Emergency battery pack, Constant Power, Title 20 Compliant with Remote Test Switch (Sidecar)	(blank) Damp Location WL[15] Wet Location

Trim Style	Trim Color	Baffle Color	Trim Lens	Trim Finish[17]	Cylinder Color	
P[3] Parabolic Trim LW[16] Lensed Wall Wash BEV[17] Bevel Trim	AR Clear Anodized BR Black Anodized GR Gold Anodized PR Pewter Anodized WTR Wheat Anodized WR[17] White Painted WRAMF[17] White with Anti-Microbial Painted WMR[17] Soft White Painted BZR[17] Dark Bronze Painted TRALTBD[18] RAL Paint TCPCTBD Custom Paint	(blank) non-Bevel ARS Clear Anodized Semi-Specular WMRS Soft White BRS Black Semi-Specular BRD Black Diffuse	(blank) no lens SLG Solite Lens CLR Clear Lens	LSS Semi Specular LS Specular LD Matte Diffuse	DWH Gloss White DBL Matte Black DNA Gloss Natural Aluminum DWHAMF Gloss White Anti-Microbial DMB Matte Medium Bronze DDB Gloss Dark Bronze DSS Gloss Sandstone DGC Gloss Charcoal Grey DTG Gloss Tennis Green DBR Gloss Bright Red DSB Gloss Steel Blue	DDBT Textured Dark Bronze DBLB Textured Black DWHG Textured White DBNH Textured Bronze DNAT Textured Natural Aluminum DSST Textured Sandstone DSPD Textured Dark Grey DSPE Textured Green DSPH Textured Light Red RALTBD[18] Cylinder RAL Paint (TBD for pricing only) CPC Cylinder Custom Paint Color

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

ORDERING NOTES

1. 05LM only available with L5 Cylinder Length and ZT or ELV. 05LM not available with E7W.
2. 90CRI not available with 50K Kelvin Temperature. 95CRI not available with 35K, 40K or 50K Kelvin Temperature.
3. Not available with WW style Function.
4. Not available with L5 Cylinder Length.
5. 347 only available with ZT Control Input. Min10LM-Max 45LM. Not available with nLight, Emergency or SF Options. Not available with L5 Cylinder Length.
6. Refer to Tech-240 for compatible dimmers.
7. ZT not available with DARK.
8. ELV only available with MIN1 and 120 volt.
9. DALI and DMX only available with DARK.
10. DMX not available with L5 Cylinder Length.
11. nLight controls are provided with each fixture and can be remote mounted or mounted to the junction box. Wired NLIGHT and NLIGHTER controls include nPS 80 EZ dimming pack. Wireless NLTAIR2 and NLTAIREM2 controls include rPP20 power pack. Includes EZT driver. See Tables of Use on page 10.
12. L5 available up to 30LM max. Not available with E7W or 347.
13. Not available with 05LM, 25LM or 30LM with EZT or DALI control input for L5 cylinder length. Not available with 05LM with EZT or DALI control input for L9, L14 or L16 cylinder lengths.
14. E7W only available with ZT or ELV. Not available with 347. Available up to 20LM max for L9. Available up to 35LM max for L14 or L16. E7W with WL available up to 15LM max.
15. WL Only available with JBX. Not available with DMX or Emergency Options. Min 05LM-30LM max for ZT or ELV in L5 Cylinder Lengths. Min 07LM-Max 20LM for EZT or DALI in L5 Cylinder Lengths. 30LM max for ZT or ELV in L9, L14 or L16 Cylinder Lengths. 07LM-30LM max for EZT or DALI in L9, L14 or L16 Cylinder Lengths.
16. LW not available with D style Function.
17. Optical finishes are not available with WR, WRAMF WMR and BZR trim colors.
18. Replace with applicable RAL number and finish when ready to order. See RAL BROCHURE for available color options.

ACCESSORIES – order as separate catalog numbers (shipped separately)

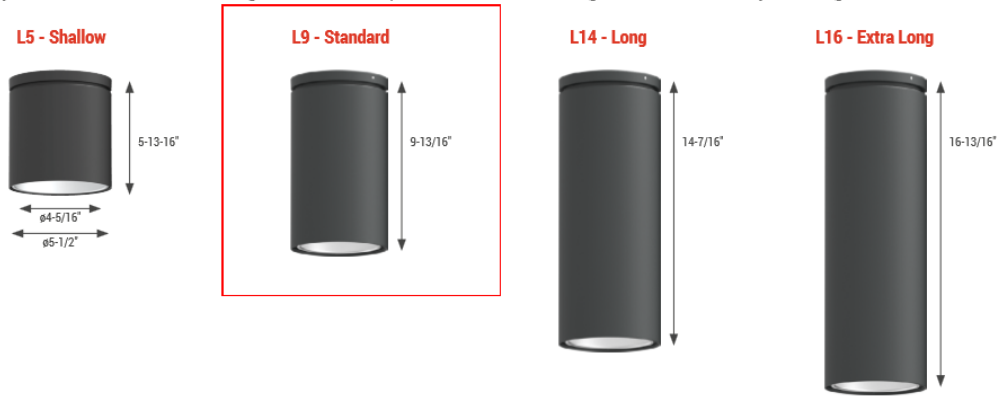
GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
GOTHAM IVO REFLECTOR COLOR KIT	Trim colors & finishes sample kit for standard IVO anodized and painted trim color options.
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting
CYLSTBL KIT	Stabilization Kit for securing pendant stem fixtures
IVO40PTC D MD	Field Replaceable 4" Downlight Optic, Medium Batwing Distribution, 0.8 s/mh, for L9-L16 Cylinder Lengths only
IVO40PTC D MWD	Field Replaceable 4" Downlight Optic, Medium Wide Batwing Distribution, 1.0 s/mh, for L9-L16 Cylinder Lengths only
NO40PTC D WD	Field Replaceable 4" Downlight Optic, Wide Batwing Distribution, 1.2 s/mh, for L9-L16 Cylinder Lengths only
IVO40PTC D 10D	Field Replaceable 4" Downlight Optic, 10°, for L9-L16 Cylinder Lengths only
IVO40PTC D 15D	Field Replaceable 4" Downlight Optic, 15°, for L9-L16 Cylinder Lengths only
IVO40PTC D 20D	Field Replaceable 4" Downlight Optic, 20°, for L9-L16 Cylinder Lengths only
IVO40PTC D 25D	Field Replaceable 4" Downlight Optic, 25°, for L9-L16 Cylinder Lengths only
IVO40PTC D 30D	Field Replaceable 4" Downlight Optic, 30°, for L9-L16 Cylinder Lengths only
IVO40PTC D 35D	Field Replaceable 4" Downlight Optic, 35°, for L9-L16 Cylinder Lengths only
IVO40PTC D 40D	Field Replaceable 4" Downlight Optic, 40°, for L9-L16 Cylinder Lengths only
IVO40PTC D 45D	Field Replaceable 4" Downlight Optic, 45°, for L9-L16 Cylinder Lengths only
IVO40PTC D 50D	Field Replaceable 4" Downlight Optic, 50°, for L9-L16 Cylinder Lengths only
IVO40PTC D 55D	Field Replaceable 4" Downlight Optic, 55°, for L9-L16 Cylinder Lengths only
IVO40PTC D 60D	Field Replaceable 4" Downlight Optic, 60°, for L9-L16 Cylinder Lengths only
IVO4SOPTIC D MD U	Field Replaceable Optic, Medium Distribution, for L5 Cylinder Length only
IVO4SOPTC D MWD U	Field Replaceable Optic, Medium Wide Distribution, for L5 Cylinder Length only
IVOSOPTC D WD U	Field Replaceable Optics, Wide Distribution, for L5 Cylinder Length only

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

LENGTH AND TRIM OPTIONS

Cylinder Length

- Dimensions in inches [centimeters]
- L5 length Cylinder has a 65° visual cut-off angle and trims and optics that are not interchangeable with the other Cylinder lengths

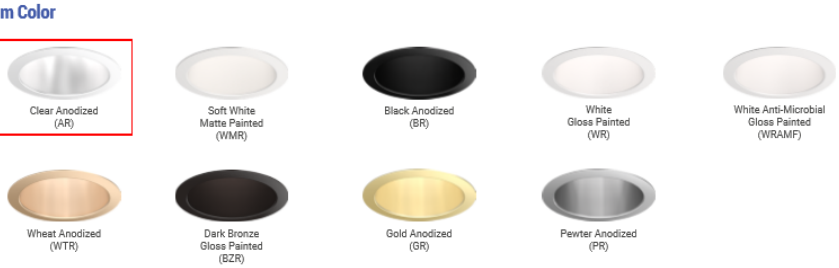


Trim Style

Optical Finish

Clear Anodized Parabolic shown

Trim Color



Parabolic shown

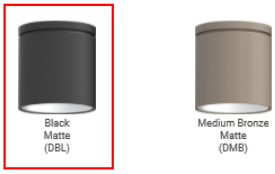
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

ARCHITECTURAL COLORS

Textured Colors

Gloss Colors

Matte Colors



Note: These colors were carefully reproduced to give as true a depiction as possible of the finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please contact a Gotham representative for an Architectural Color Chip Kit (GCOLORS KIT), consisting of Powder-Coated and Plated Finishes.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

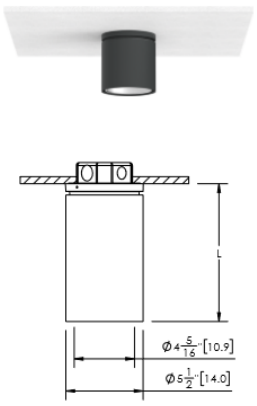
DIMENSIONAL DATA

Surface Mounting Options

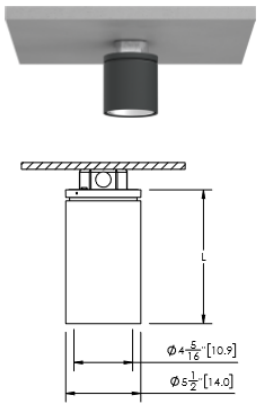
- Dimensions in inches [centimeters]
- J-boxes available by others. (see Compatibility Table).

CYLINDER	LENGTH (L) DIMENSIONS INCHES [CM] JBX	JBXCC
L5	5-13/16" [14.8]	7-3/4" [19.7]
L9	9-13/16" [24.9]	11-3/4" [29.8]
L14	14-7/16" [36.7]	16-3/8" [41.6]
L16	16-13/16" [42.7]	18-3/4" [47.6]

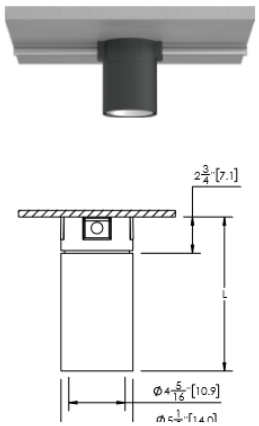
Surface Mount with Recessed J-box (JBX)



Surface Mount with Surface J-box (JBX)



Surface Mount Conduit Cover with Surface J-box (JBXCC)



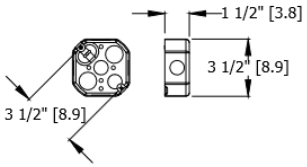
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

JUNCTION BOX AND CANOPY

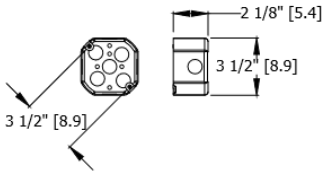
Junction Box Details

- Dimensions in inches [centimeters]
- J-boxes available by others. (see Compatibility Table).

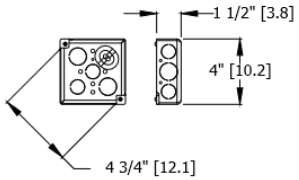
4" Octagonal j-box, 1-½" deep



4" Octagonal j-box, 2-1/8" deep

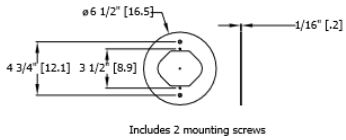


4" Square j-box, 1-½" deep

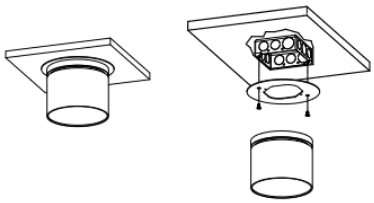


Mounting Compatibility Matrix		Cylinder Configurations	
		JBX	JBXCC
J-box (by others)	4" Octagonal 3.5x3.5x1.5 deep	✓	✓
	4" Octagonal 3.5x3.5x2.1 deep	✓	✗
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	✗

Cylinder Adaptor Plate (CYLJBOXADPT 4SQ20CT)



Includes 2 mounting screws



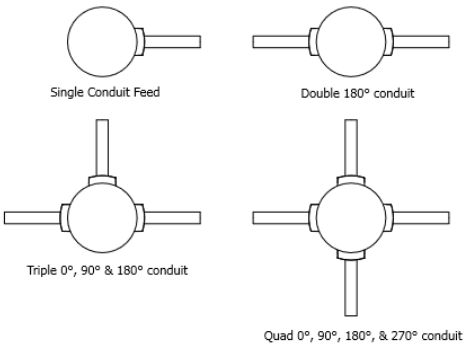
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

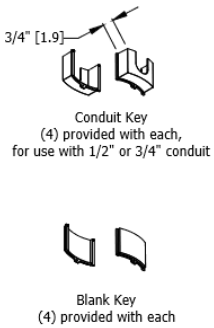
JUNCTION BOX AND CANOPY

Conduit Covers and Emergency Battery Sidecar

- Dimensions in inches [centimeters]
- J-boxes available by others. (see Compatibility Table).

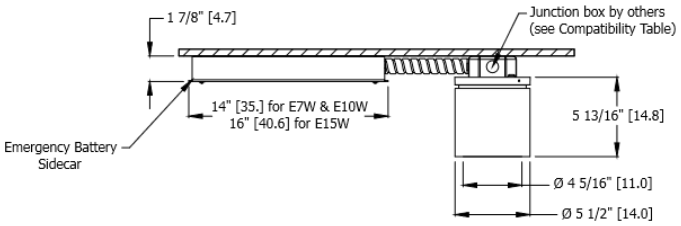
Conduit Cover



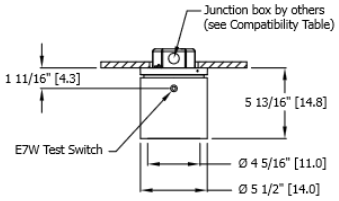


Emergency Battery Sidecar Enclosure

Emergency Battery Remote Test Switch (E7WR, E10WR, E15WR)



Emergency Battery Integral Test Switch (E7W)



How to Estimate Delivered Lumens in Emergency Mode
Delivered Lumens = 1.25 x P x LPW
P = Output Power/Wattage of Emergency Battery Driver (E7WR* = 7W, E10WR* = 10W, E15WR* = 15W)
LPW = Lumen per Watt rating of luminaire based on Ordering Code selections

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

SPECIFICATIONS

Optical System
- Bounding Ray™ optical design delivers low brightness apertures for a comfortable lighting experience. Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare.
- 45° visual cut-off angle to source for L9, L14 and L16 lengths and 65° visual cut-off for L5 length per CIE 117-1995 Discomfort Glare in Interior Lighting (UGR FAQ)
- Top-Down Flash characteristics avoid flash on trim until source becomes visible.
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture. Available with 0.8, 1.0, and 1.2 spacing-to-mounting-height ratio (s/mh).
- Clean beams with soft transitions from narrow spot 10° up to wide flood 60° distributions and available every 5°.
- Optics are field changeable. However, L5 Cylinder Length optics are not interchangeable with other Cylinder Length optics.

LED Light Engine
- Perfect Color™ consistency within 1/2-step MacAdam Ellipse using proprietary pick and place algorithm.
- 90% lumen maintenance at 55,000 hours.
- Available in 80, 90, or 95 CRI. 90 CRI has R9 greater than 50, 95 CRI has R9 greater than 80.

Trims
- Trims are field changeable via twist-lock (tool-free). However L5 Cylinder Length trims are not interchangeable with other Cylinder Lengths.
- Trims are available in 9 colors and 3 surface finishes (standard)
- Custom RAL and Paint colors available upon request.
- Trim lenses are made of Tempered Glass

Electrical
- 120, 277, 347, or Multi-Volt (MVOLT) 120-277 VAC input at 50/60 Hz.
- Power Factor > 85%.
- Input wires 18 AWG, 600V minimum, solid copper.

EMI/RFI
- EMI/RFI per FCC Title 47 CFR, Part 15, Class A rated standard.
- EMI/RFI per FCC Title 47 CFR, Part 15, Class B rated for Phase Dimming driver (ELV) except when used with Emergency Battery (E7WR, E10WR, E15WR) or at 15LM and above.

Controls (Optional)
- Luminaire can be equipped with interface for nLight wired, allowing it to communicate over an nLight network. nLight wired options ship with an nPS 80 EZ power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Couple with nLight-enabled sensors, power packs, or WallPods using CAT-5 cabling to create an nLight Control Zone. Link Control Zone to a Gateway directly or via a Bridge for remote status monitoring and control using SensorView software.
- Luminaire can be equipped with interface for nLight Air, allowing it to communicate over the wireless nLight control platform. nLight Air options ship with an rPP20 power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Can be paired to other luminaires and wall switches through CLAIRITY+, a mobile app, which allows individual fixture control.

Dimming
- Luminaire Is capable of continuous dimming without perceivable flicker (stroboscopic) as measured by flicker index (ASNI/IES RP-16-10).
- Available dimming ranges include: 100%-10% (MIN10), 100%-1% (MIN1), and 100%-0.1% (DARK) of rated lumen output.
- Available with smooth shut off function from minimum dimming level to 0%.
- EldoLED drivers (EZT, DALI) conform to IEEE P1789 standards.
- Drivers are inaudible in 24dB environment and stable even when input voltage conditions experience typical commercial environment fluctuations.

Emergency Battery (Optional)
- Luminaires equipped with battery pack (E7W, E7WR, E10WR, E15WR) comply with NFPA 101 (Life Safety Code) and deliver constant light output for a duration of 90 minutes minimum with AC power loss.
- Emergency batteries with Remote Test Switch (E7WR, E10WR, E15WR) are mounted to ceiling via remote enclosure (sidecar).
- Emergency battery is CEC T20 compliant.

Installation
- Luminaire can be installed to 4" Octagonal j-box (1-1/2" or 2-1/8" deep depending on ordering configuration).
- Luminaire can be installed to 4" Square j-box (1-1/2" deep) when used with Cylinder Adaptor Plate (CLYLJBOXADPT 4SQ20CT).
- Optional, field configurable Conduit Covers are available and match Cylinder finish and diameter.

Construction
- Heavy-gauge extruded Aluminum construction.
- Reflector design allows air flow across heatsink to improve thermal management.
- Light Engine and Driver are field replaceable and serviceable from below the ceiling.

Listings
- Fixtures are CSA certified to meet US and Canadian standards.
- All fixtured are manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" per UL.
- Damp Location standard.
- Wet Location available.

Photometrics
- All photometry is conducted by IESNA standard LM-79-08 in an accredited lab.
- LEDs are tested to LM-80 standards. Lumen maintenance is calculated via TM-21.

Warranty
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:
- Actual performance may differ as a result of end-user environment and application.
- All values are design or typical values, measured under laboratory conditions at 25 °C.
- The product images shown are for illustration purposes only and may not be an exact representation of the product.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

TABLES OF USE

Dimming Configurations

Dimming Level		Control Input	Dimming Level	Driver Dim Curve	Recommended Control Dim Curve
MIN10	+	ZT	100% to 10%	Linear	Linear/Logarithmic
	+	EZT	100% to 10%	Linear	Linear/Logarithmic
MIN1	+	ZT	100% to 1%	Linear	Linear/Logarithmic
	+	EZT	100% to 1%	Linear	Linear/Logarithmic
	+	ELV	100% to 1%*	n/a	n/a
DARK	+	EZT	100% to 0.1%	Logarithmic	Linear
	+	DMX	100% to 0.1%	Square	Linear
	+	DALI	100% to 0.1%	Logarithmic	Linear

* ELV Minimum Dimming level depends on dimmer and dimmer load

Night Configurations

Dimming Level		Control Input	Dimming Level	Control Provided	Driver Provided
MIN10	+	NLIGHT	100% to 10%	NPS 80 EZ	eldoLED ECOdrive
	+	NLIGHTER	100% to 10%	NPS 80 EZ ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 10%	RPP20	eldoLED ECOdrive
	+	NLTAIREM2	100% to 10%	RPP20 EM	eldoLED ECOdrive
MIN1	+	NLIGHT	100% to 1%	NPS 80 EZ	eldoLED ECOdrive
	+	NLIGHTER	100% to 1%	NPS 80 EZ ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 1%	RPP20	eldoLED ECOdrive
	+	NLTAIREM2	100% to 1%	RPP20 EM	eldoLED ECOdrive
DARK	+	NLIGHT	100% to 0.1%	NPS 80 EZ	eldoLED SOLOdrive
	+	NLIGHTER	100% to 0.1%	NPS 80 EZ ER	eldoLED SOLOdrive
	+	NLTAIR2	100% to 0.1%	RPP20	eldoLED SOLOdrive
	+	NLTAIREM2	100% to 0.1%	RPP20 EM	eldoLED SOLOdrive

IVO4CYL D L5		Drivers:	Title 24, JA8 ZT, ELV	Energy Star EZT, ZT, ELV, DALI
DOWNLIGHT	80CRI	2700K		✓[2]
		3000K		✓[2]
		3500K		✓[2]
		4000K		✓[2]
		5000K		✓[2]
	90CRI	2700K		✓[2,3]
		3000K		✓[2,3]
		3500K	✓[1]	✓[2,3]
		4000K	✓[1]	✓[2,3]
	95CRI	2700K	✓[1]	
		3000K	✓[1]	

Applicable for L5 length Downlight Cylinders only.
1 - E7WR, E10WR, and E15WR are not T24 complaint.
2 - E7WR is not Energy Star complaint.
3 - 90CRI with 05LM and ELV or ZT is not Energy Star complaint.

IVO4CYL WW L5		Drivers:	Title 24, JA8 ZT, ELV	Energy Star EZT, ZT, ELV, DALI
WALL WASH	80CRI	2700K		✓[1,2]
		3000K		✓[1,2]
		3500K		✓[1,2]
		4000K		✓[1,2]
		5000K		✓[1,2]
	90CRI	2700K		✓[1,2]
		3000K		✓[1,2]
		3500K		✓[1,2]
		4000K		✓[1,2]
	95CRI	2700K		
		3000K		

Applicable for L5 length Wall Wash Cylinders only.
1 - E7WR is not Energy Star complaint.
2 - 05LM and 07LM are not Energy Star complaint.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

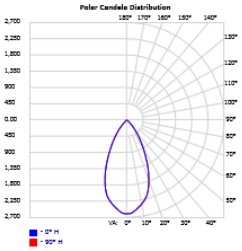
To learn more about A+, visit www.acuitybrands.com/aplus.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

PHOTOMETRY

MD Medium Beam

IVO4CYL SC D 20LM 35K 80CRI 35D L9/L14/L16 P AR LSS **Wattage: 20.5, Lumens: 1920, LPW: 94, S/MH: ..8, Test No: 24-850-22P5062**



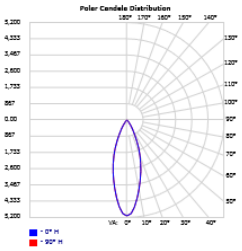
Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

35 Degree Beam

IVO4CYL SC D 20LM 35K 80CRI 50D L9/L14/L16 P AR LSS **Wattage: 20.5, Lumens: 2044.6, LPW: 100, S/MH: .54, Test No: 24-850-34P2097**



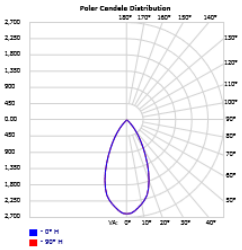
Candela Summary	
0°	5116
10°	3734
20°	2039
30°	675
40°	120
50°	14
60°	4
70°	2
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1778.1	87.0%
0-40	1992.7	97.5%
0-60	2040.2	99.8%
0-90	2044.6	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	79.94	4.8	4.8
10'	51.16	6	6
12'	35.53	7.2	7.2
14'	26.1	8.4	8.4
16'	19.99	9.6	9.6

50 Degree Beam

IVO4CYL SC D 20LM 35K 80CRI MD L9/L14/L16 P AR LSS **Wattage: 20.5, Lumens: 1920.1, LPW: 94, S/MH: .8, Test No: 24-850-11P5070**



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

CRI/CCT Multiplier		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Trim Color and Finish Multiplier		
Trim Color	Trim Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

UGR (70% 50% 20% reflectance using a 4H x 8H room size)						
Lumen Package	Crosswise			Endwise		
	MD	MWD	WD	MD	MWD	WD
05LM	7.9	4.9	4.9	7.9	4.9	4.9
07LM	9.2	6.2	6.2	9.2	6.2	6.2
10LM	10.3	7.3	7.3	10.3	7.3	7.3
15LM	11.4	8.4	8.4	11.4	8.4	8.4
20LM	12.3	9.4	9.3	12.3	9.4	9.3
25LM	13	10.1	10.1	13	10.1	10.1
30LM	13.6	10.6	10.6	13.6	10.6	10.6

*UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.

**Calculated using an AR (Clear reflector) with LSS (Semi-Specular) finish

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

PHOTOMETRY

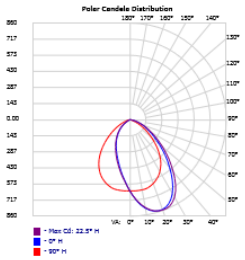
Superior Performance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	340	507	683	1025	1357	1687	1884	2285	2618	2921
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	66	69	69	69	66	63	63	66	63	64

*Based on Lensed Wall Wash performance: 3500K 80CRI MD P AR LSS, for L9, L14, and L16. See IES files available online for L5 performance.

LW Lensed Wall Wash

IVO4CYL SC WW 20LM 35K 80CRI L9/L14/L16 LW AR LSS Wattage: 20.5, Lumens: 1357.4, LPW:66, S/MH: 1.5, Test No: 24-824-1P444



Candela Summary	
0°	633
10°	800
20°	851
30°	759
40°	550
50°	346
60°	199
70°	101
80°	32
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	503.8	37.1%
0-40	804.4	59.3%
0-60	1238.8	91.3%
0-90	1357.4	100.0%

CRI/CCT Multiplier		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Trim Color and Finish Multiplier		
Trim Color	Trim Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

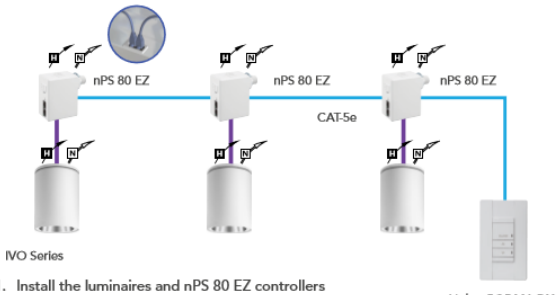
NLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Controls



1. Install the luminaires and nPS 80 EZ controllers and make the low-voltage connections
2. Install the nLight Wired wall switch
3. Connect the nLight devices using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Controls

1. Install the luminaires and rPP20 power/relay packs
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY™+ mobile app to pair the luminaires with the wall switch and if desired, customize the device settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	ICO2STRC 30/20 AR-LSS-5020D-MVOT-UGZ-SGBCC-DBL
TOTAL WATTS	28.6
VOLTAGE	120/277
MOUNTING	Surface
WEIGHT	
DIMENSIONS	
FINISH	Black
RATING	IP
LISTING	

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2000
ANTICIPATED LIFE	50000

POWER SUPPLY

TYPE	
PROVIDED BY	

ACCESSORIES

Surface mount adjustable cylinder with one (1) LED lighting source, 2000 delivered lumens, 3000K color engine, 80+ CRI, 50x20 optic. Cylinder should operate on 120/277 voltage and be supplied with a 0-10v control option down to 1% with a 50000 hour anticipated life. Cylinder to have black finish.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

gotham® | INCITO™

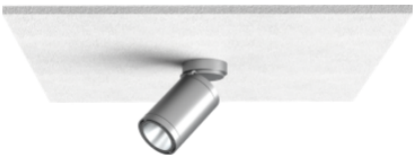
Multiple Layers of Light

Luminaire Type:

Catalog Number:

Buy American

High Center Beam Tilt/Rotate Surface Ceiling Cylinder 2"

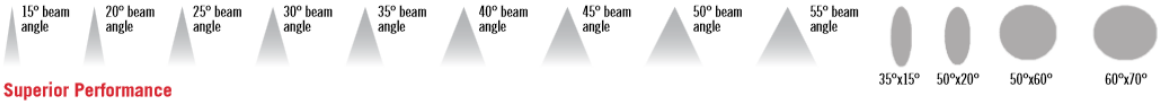


OVERVIEW

Feature Set

- Adjustable tilt (90°) and rotation (365°)
- Thirteen optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 50° Cutoff to source and source image
- Field interchangeable optic
- Surface mounted or recessed mounted driver options
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling (WL option) available
- ENERGY STAR® Certified product
- 20 standard colors in textured and gloss finish; custom & RAL colors also available

Distribution



Superior Performance

Nominal lumens	250	500	750	1000	1500	2000
Delivered	263	560	859	1177	1764	2227
Wattage	3.1	5.6	8.7	12.0	19.8	28.6
Efficacy	85	100	99	98	89	78

*Based on 3500K 80CRI 15D AR LSS

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Healthcare

Special Applications

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham | INCITO™

2" High Center Beam Tilt/Rotate Surface Ceiling Cylinder

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Luminaire Type:

Catalog Number:

EXAMPLE: IC02STRC 35/10 AR LSS 20D MVOLT UGZ RGH DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Beam	
IC02STRC	Incito 2in Round Surface Ceiling Tilt/ Rotate Cylinder Open Downlight	27/	2700 K	02	250 lumens	AR	Clear	LSS	Semi-specular	15D	15° beam angle
		30/	3000 K	05	500 lumens	PR	Pewter	LD	Matte diffuse	20D	20° beam angle
		35/	3500 K	07	750 lumens	WTR	Wheat			25D	25° beam angle
		40/	4000 K	10	1000 lumens	GR	Gold			30D	30° beam angle
		50/[1]	5000 K	15	1500 lumens	WR[2]	White painted			35D	35° beam angle
				20	2000 lumens	BR[2]	Black painted			40D	40° beam angle
						BZR[2]	Dark Bronze painted			45D	45° beam angle
										50D	50° beam angle
										55D	55° beam angle
										3515D	Elliptical 35° x 15° beam angle
										5020D	Elliptical 50° x 20° beam angle
										5060D	Elliptical 50° x 60° beam angle
										6070D	Elliptical 60° x 70° beam angle

Voltage		Driver		Mounting		Control Interface[5]	
MVOLT	120V - 277V	UGZ[3]	Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	RGH[4]	Recessed Gear Housing	(blank)	
120	120V			SGB	Surface Gear Box	NLT	nLight® dimming pack.
277	277V			SGBPR	Surface Gear Box with Concealed Plaster Ring	NLTER[6]	nLight® dimming pack for fixtures on emergency circuit
				SGBCC	Direct Conduit Surface Gear Box	NLTAIR2	nLight® AIR dimming pack.
				JBXCC	Surface J-Box with Conduit Covers	NLTAIRER2[6]	nLight® AIR dimming pack for fixtures on emergency circuit
						NLTAIREM2	nLight® AIR dimming pack for fixtures on emergency circuit

Options		Architectural Colors - Powder Paint[9]			
90CRI[1]	High CRI (90+)	DDB	Gloss Dark Bronze	DDBT	Textured Dark Bronze
N80[7]	nLight Lumen Compensation	DBL	Matte Black	DBLB	Textured Black
WL[8]	Wet Location	DWH	Gloss White	DWHG	Textured White
		DMB	Matte Medium Bronze	DBNH	Textured Bronze
		DNA	Gloss Natural Aluminum	DNAT	Textured Natural Aluminum
		DSS	Gloss Sandstone	DSST	Textured Sandstone
		DGC	Gloss Charcoal Grey	DSPD	Textured Dark Grey
		DTG	Gloss Tennis Green	DSPE	Textured Green
		DBR	Gloss Bright Red	DSPH	Textured Light Red
		DSB	Gloss Steel Blue	DWHAMF	Gloss White with Anti-microbial finish

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes.
IC020PTC XXD	Additional optics for field installation. Replace "XX" with beam angle.
IC020PTC KIT	Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns
HS234FL	Hole saw for RGH option
SDT 347/120 75VA	347V/120V, 75VA step down transformer. Must be remote mounted.

ORDERING NOTES

1. 5000K CCT not available with 90CRI.
2. Not available with Reflector Finish.
3. Refer to Tech 240 for compatible dimmers.
4. RGH with 2000LM option requires 120 or 277 (non-IC).
5. Field installed. Access required to location of remote mounted device.
6. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
7. Requires NLT or NLTER.
8. Not available with SGBCC or JBXCC.
9. For details on RAL and Custom colors please see Architectural colors.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham

SPECIFICATIONS

Optical and Trim Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 50° cutoff to source and source image. Top down flash characteristic for superior glare control.

Superior 100% Virgin-silicone refractive optic, enables maximum dimensional stability and optical transmission with no discoloration over life. Field inter-changeable optics.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages. THD @ Full Load is >20%. Inrush current meets NEMA-410 requirments. Surge Protection +/- 1kV DM, +/- 2kV CM.

Controls

Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 1.0% of rated lumen output with a smooth shut off function to step to 0%.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Surface Gear Box (SGB) for direct installation to 4" recessed or surface octagonal (by others).

Recessed Gear Housing (RGH) ships with driver box for recessed or surface installation.

Die cast with flangeless reflector allows flow-through passive thermal management.

Accommodates between 3/8" to 3"-thick ceilings.

Listings

Fixtures are UL Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location covered ceiling optional (WL).

RGH option is IC rated up to 1500LM

Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed

Buy American

This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FARS, DFARS and DOT. Please refer to https://www.acuitybrands.com/resources/buy-american for additional information.

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Warranty

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.910
	3000K	0.946
	3500K	1.000
	4000K	1.027
	5000K	1.054
90	2700K	0.784
	3000K	0.847
	3500K	0.874
	4000K	0.946

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LSS - Semi Specular	1.00
LD - Matte Diffuse	0.98
Reflector Color	**Multiplier**
WR - White	0.98
BR - Black	0.92
BZR - Bronze	0.91
AR - Clear	1.00
GR - Gold	0.99
PR - Pewter	0.99
WTR - Wheat	0.98

Driver		Control Provided				
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIREM2	NLTAIRER2
UGZ	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations	
		SGB	RGH
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep (by others)	✓	✗
	4" Octagonal 4x4x2.125 deep (by others)	✓	✗
	Factory Provided Gear Box (4" Square 4x4x1.5 deep)	✗	✓

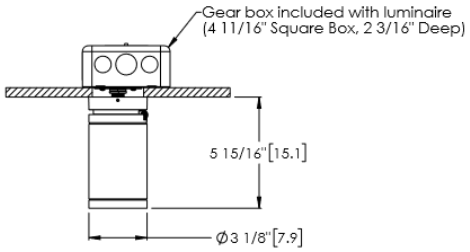
Standard Architectural Color Options for Cylinder Bodies

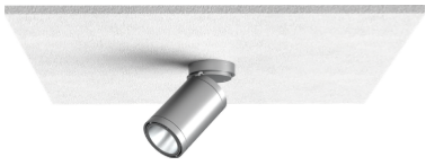
NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please always contact a Gotham representative for an accurate paint chip sample.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

DIMENSIONAL DATA

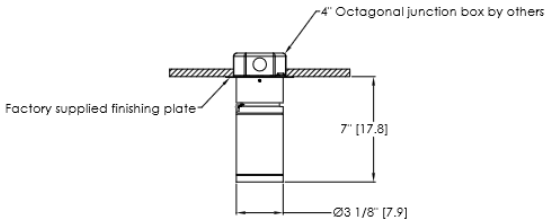
RGH - Recessed Gear Housing



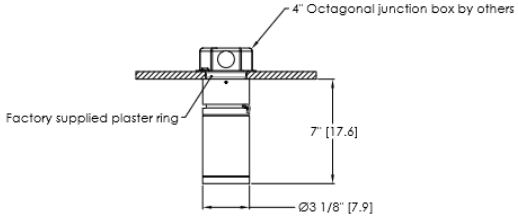


Ceiling cutout: Ø2 3/4" [7]
Ceiling thickness range: 3/8" [1.0] to 3" [7.6]

SGB - Surface Gear Box



SGBPR - Surface Gear Box with Plaster Ring



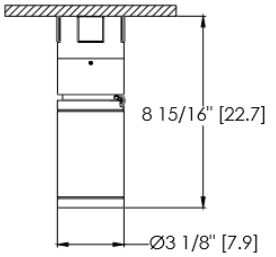
*Dimensions in inches [centimeters]

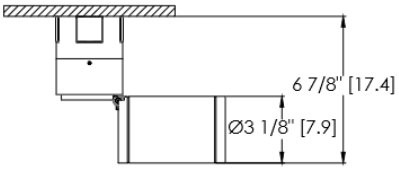
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham®

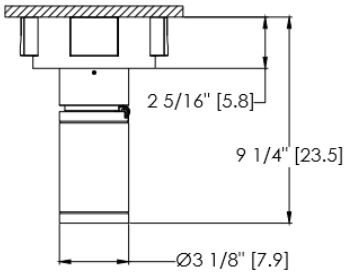
DIMENSIONAL DATA

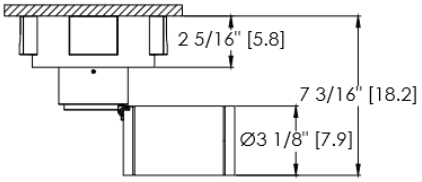
SGBCC - Direct Conduit Surface Gear Box

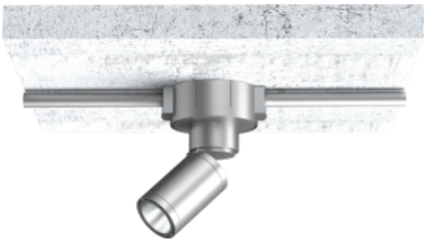




JBXCC - Surface J-Box with Conduit Covers







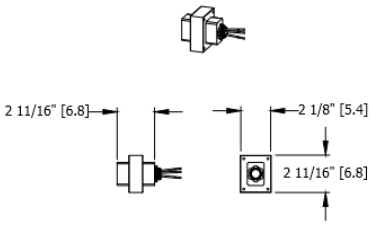
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham®

DIMENSIONAL DATA

347V Transformer



347 Transformer:
Install to accessible
junction box by others

*Dimensions in inches [centimeters]

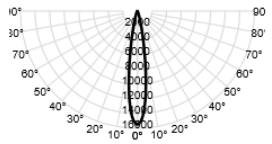
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham®

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY

ICO2STRC 35/15 AR LSS 15D Input Watts: 19.8, Delivered Lumens: 1764, LPW: 89.1, S/MH: 0.28, Test No: 19-383-01P713

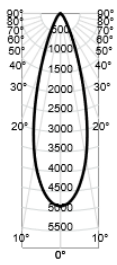


CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	15,477	0° - 30°	1,650	94%	
5°	12,289	0° - 40°	1,721	98%	
15°	1,789	0° - 60°	1,761	100%	
25°	320	0° - 90°	1,764	100%	
35°	113	90° - 180°	0	0%	
45°	41	0° - 180°	1,764	100%	
55°	8				
65°	2				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	113	112	110	111	110	108	107	106	105	
2	109	106	104	107	105	103	104	102	100	
3	105	101	99	103	100	98	101	99	97	
4	101	98	95	100	97	94	98	96	93	
5	98	94	92	97	94	91	96	93	91	
6	95	92	89	95	91	89	94	91	88	
7	93	89	87	92	89	87	91	88	86	
8	91	87	85	90	87	85	90	86	84	
9	89	85	83	88	85	83	88	85	83	
10	87	84	81	87	83	81	86	83	81	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	429.9	1.7	0°	5,875,626
8.0	241.8	2.3	45°	22,013
10.0	154.8	2.9	55°	4,964
12.0	107.5	3.5	65°	1,886
14.0	79.0	4.1	75°	1,027
Beam Angle: 16.6°			85°	871
Field Angle: 31.5°				

ICO2STRC 35/15 AR LSS 30D Input Watts: 19.8, Delivered Lumens: 1679, LPW: 84.8, S/MH: 0.51, Test No: 19-383-04P713

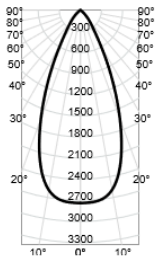


CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	4,876	0° - 30°	1,439	86%	
5°	4,562	0° - 40°	1,588	95%	
15°	2,498	0° - 60°	1,674	100%	
25°	742	0° - 90°	1,679	100%	
35°	228	90° - 180°	0	0%	
45°	91	0° - 180°	1,679	100%	
55°	15				
65°	4				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	112	110	108	110	108	106	106	104	103	
2	106	102	99	104	101	98	101	98	96	
3	100	96	93	99	95	92	96	93	90	
4	95	91	87	94	90	87	92	88	86	
5	91	86	82	90	85	82	88	84	81	
6	87	82	78	86	81	78	85	80	77	
7	83	78	75	82	78	74	81	77	74	
8	80	75	71	79	74	71	78	74	71	
9	77	72	68	76	72	68	75	71	68	
10	74	69	66	73	69	66	73	68	66	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	135.4	3.3	0°	1,850,977
8.0	76.2	4.4	45°	48,643
10.0	48.8	5.5	55°	9,862
12.0	33.9	6.5	65°	3,234
14.0	24.9	7.6	75°	1,614
Beam Angle: 30.5°			85°	871
Field Angle: 56.8°				

ICO2STRC 35/15 AR LSS 45D Input Watts: 19.8, Delivered Lumens: 1662, LPW: 83.9, S/MH: 0.72, Test No: 19-383-07P713

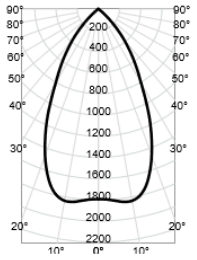


CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	2,739	0° - 30°	1,337	80%	
5°	2,721	0° - 40°	1,548	93%	
15°	2,216	0° - 60°	1,657	100%	
25°	1,047	0° - 90°	1,662	100%	
35°	322	90° - 180°	0	0%	
45°	116	0° - 180°	1,662	100%	
55°	16				
65°	4				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	111	109	107	109	107	105	105	104	102	
2	104	101	98	103	99	96	99	97	94	
3	98	94	90	97	93	89	94	91	88	
4	92	87	83	91	87	83	89	85	82	
5	87	82	78	86	81	78	85	80	77	
6	83	77	73	82	77	73	80	76	73	
7	78	73	69	78	73	69	77	72	69	
8	75	69	65	74	69	65	73	68	65	
9	71	66	62	71	65	62	70	65	62	
10	68	63	59	67	62	59	67	62	59	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	76.1	4.9	0°	1,039,647
8.0	42.8	6.5	45°	62,226
10.0	27.4	8.2	55°	10,789
12.0	19.0	9.8	65°	3,414
14.0	14.0	11.4	75°	1,760
Beam Angle: 44.4°			85°	1,307
Field Angle: 73.4°				

ICO2STRC 35/15 AR LSS 55D Input Watts: 19.8, Delivered Lumens: 1697, LPW: 85.7, S/MH: 0.90, Test No: 19-383-09P713



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	1,793	0° - 30°	1,168	69%	
5°	1,815	0° - 40°	1,528	90%	
15°	1,730	0° - 60°	1,692	100%	
25°	1,144	0° - 90°	1,697	100%	
35°	574	90° - 180°	0	0%	
45°	190	0° - 180°	1,697	100%	
55°	13				
65°	4				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization										
pf			80%			20%			50%	
pc						70%			30%	
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%	
0	119	119	119	116	116	116	111	111	111	
1	111	108	106	109	106	104	104	103	101	
2	103	99	95	101	97	94	98	95	92	
3	96	91	87	94	90	86	92	88	85	
4	89	84	80	88	83	79	86	82	78	
5	84	78	73	83	77	73	81	76	72	
6	78	72	68	78	72	68	76	71	67	
7	74	67	63	73	67	63	72	66	63	
8	69	63	59	69	63	59	68	62	59	
9	65	59	55	65	59	55	64	59	55	
10	62	56	52	61	56	52	60	55	52	

Cone of Light			Luminance (cd/sq.m)	
Mounting Height	Initial FC Center Beam	Beam Diameter		Average Luminance
6.0	49.8	6.4	0°	680,772
8.0	28.0	8.6	45°	102,010
10.0	17.9	10.7	55°	8,803
12.0	12.5	12.9	65°	3,144
14.0	9.1	15.0	75°	1,760
Beam Angle: 56.5°			85°	1,307
Field Angle: 90.4°				

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

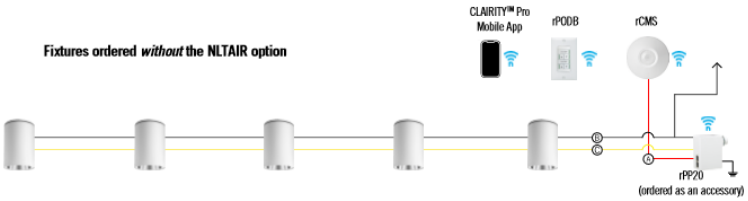
gotham

NLIGHT AIR

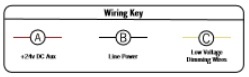
nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option



Fixtures ordered *with* the NLTAIR option



nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

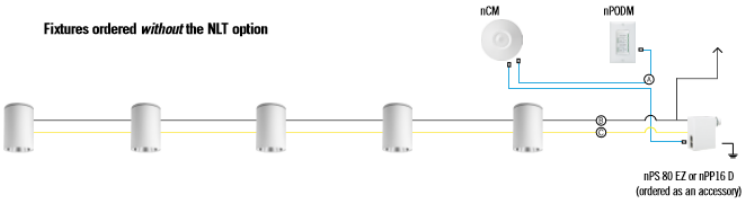
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

NLIGHT

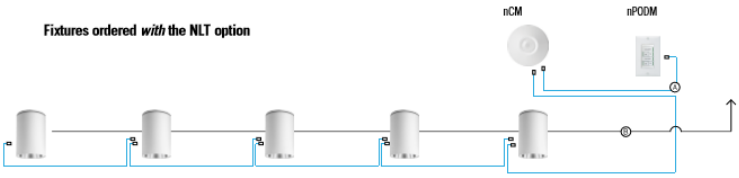
nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

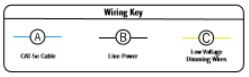
Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option





nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

Wall Switches	Model Number
On/Off single pole	nPODM (XX)
On/Off two pole	nPODM 2P (XX)
On/Off & raise/lower single pole	nPOD DX (XX)
On/Off & raise/lower two pole	nPODM 2P DX (XX)
Graphic touchscreen	nPOD GFX (XX)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2022 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 09/15/22 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham®

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	ICO2STRC-30/20-AR-LSS-25D-MVOLT-UZG-SGB-DBL
TOTAL WATTS	28.55
VOLTAGE	MVOLT
MOUNTING	Surface
WEIGHT	
DIMENSIONS	3.125 x 3.125 x 6
FINISH	Matte Black
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2000
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

Surface mount adjustable cylinder with one (1) LED lighting source, 2000 delivered lumens, 3000K color engine, 80+ CRI, 25° optic and remote driver. Cylinder should operate on MVOLT voltage and be supplied with a 0-10v control option down to 1% with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Cylinder to have matte black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

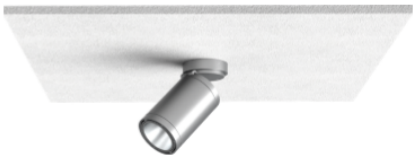
gotham | INCITO®

Luminaire Type:

Catalog Number:

BAA BABA nLIGHT

High Center Beam Tilt/Rotate Surface Ceiling Cylinder 2"

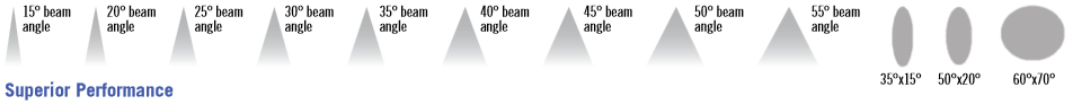


OVERVIEW

Feature Set

- Adjustable tilt (90°) and rotation (365°)
- Thirteen optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 50° Cutoff to source and source image
- Field interchangeable optic
- Surface mounted or recessed mounted driver options
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling (WL option) available
- 20 standard colors in textured and gloss finish; custom & RAL colors also available

Distribution



Superior Performance

Nominal Lumens	02LM	05LM	07LM	10LM	15LM	20LM
Delivered Lumens	284	543	813	1093	1647	2112
Wattage	3.13	5.55	8.48	11.93	19.8	28.55
Lumens per Watt	91	98	96	92	83	74

*Based on 3500K AR LSS 15D 80CRI

MULTIPLE LAYERS OF LIGHT

Incito & EVO Product Families | Building Layers of Light

High Center Beam Layer | Incito

General Illumination Layer | EVO

EVO + Incito — Multiple Layers of Light

Visit: Core | Special Applications | Healthcare

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham INCITO®

2" High Center Beam Tilt/Rotate Surface Ceiling Cylinder

Luminaire Type:

Catalog Number:

ORDERING INFORMATION

EXAMPLE: ICO2STRC 35/10 AR LSS 20D MVOLT UGZ RGH DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Beam	
ICO2STRC	Incito 2in Round Surface Ceiling Tilt/ Rotate Cylinder Open Downlight	27/	2700 K	02	250 lumens	AR	Clear	LSS	Semi-specular	15D	15° beam angle
		30/	3000 K	05	500 lumens	PR	Pewter	LD	Matte diffuse	20D	20° beam angle
		35/	3500 K	07	750 lumens	WTR	Wheat			25D	25° beam angle
		40/	4000 K	10	1000 lumens	GR	Gold			30D	30° beam angle
		50/[1]	5000 K	15	1500 lumens	WR[2]	White painted			35D	35° beam angle
				20	2000 lumens	BR[2]	Black painted			40D	40° beam angle
						BZR[2]	Dark Bronze painted			45D	45° beam angle
										50D	50° beam angle
										55D	55° beam angle
										3515D	Elliptical 35° x 15° beam angle
										5020D	Elliptical 50° x 20° beam angle
										6070D	Elliptical 60° x 70° beam angle

Voltage		Driver		Mounting		Control Interface[5]	
MVOLT	120V - 277V	UGZ[3]	Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	RGH[4]	Recessed Gear Housing	(blank)	
120	120V			SGB	Surface Gear Box	NLT	Embedded wired controls by nLight
277	277V			SGBPR	Surface Gear Box with Concealed Plaster Ring	NLTER[6]	Embedded wired controls by nLight with UL924 listed emergency operation
				SGBCC	Direct Conduit Surface Gear Box	NLTAIR2	Embedded wireless controls by nLight
				JBXCC	Surface J-Box with Conduit Covers	NLTAIRER2[6]	Embedded wireless controls by nLgiht with UL924 listed emergency operation via power sense leads
						NLTAIREM2	Embedded wireless controls by nlight with UL924 listed emergency operation

Options		Architectural Colors - Powder Paint[9]			
90CRI[1]	High CRI (90+)	DDB	Gloss Dark Bronze	DDBT	Textured Dark Bronze
N80[7]	nLight Lumen Compensation	DBL	Matte Black	DBLB	Textured Black
WL[8]	Wet Location	DWH	Gloss White	DWHG	Textured White
		DMB	Matte Medium Bronze	DBNH	Textured Bronze
		DNA	Gloss Natural Aluminum	DNAT	Textured Natural Aluminum
		DSS	Gloss Sandstone	DSST	Textured Sandstone
		DGC	Gloss Charcoal Grey	DSPD	Textured Dark Grey
		DTG	Gloss Tennis Green	DSPE	Textured Green
		DBR	Gloss Bright Red	DSPH	Textured Light Red
		DSB	Gloss Steel Blue	DWHAMF	Gloss White with Anti-microbial finish

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes.
ICO2OPTC XXD	Additional optics for field installation. Replace "XX" with beam angle.
ICO2OPTC KIT	Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns
HS234FL	Hole saw for RGH option
SDT 347/120 75VA	347V/120V, 75VA step down transformer. Must be remote mounted.

ORDERING NOTES

1. 5000K CCT not available with 90CRI.
2. Not available with Reflector Finish.
3. Refer to Tech 240 for compatible dimmers.
4. RGH with 2000LM option requires 120 or 277 (non-IC).
5. Field installed. Access required to location of remote mounted device.
6. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
7. Requires NLT or NLTER.
8. Not available with SGBCC or JBXCC.
9. For details on RAL and Custom colors please see Architectural colors.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

SPECIFICATIONS

Optical and Trim Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 50° cutoff to source and source image. Top down flash characteristic for superior glare control.

Superior 100% Virgin-silicone refractive optic, enables maximum dimensional stability and optical transmission with no discoloration over life. Field inter-changeable optics.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted step-down transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages. THD @ Full Load is >20%. Inrush current meets NEMA-410 requirments. Surge Protection +/- 1kV DM, +/- 2kV CM.

Controls

Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 1.0% of rated lumen output with a smooth shut off function to step to 0%.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Surface Gear Box (SGB) for direct installation to 4" recessed or surface octagonal (by others).

Recessed Gear Housing (RGH) ships with driver box for recessed or surface installation.

Die cast with flangeless reflector allows flow-through passive thermal management.

Accommodates between 3/8" to 3"-thick ceilings.

Listings

Fixtures are UL Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location covered ceiling optional (WL).

RGH option is IC rated up to 1500LM

Government Procurement

BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act Please refer to www.acuitybrands.com/buy-american for additional information

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Warranty

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

TABLES OF USE

Lumen Output Multiplier		
CRI	CCT	Multiplier
80	2700K	0.910
	3000K	0.946
	3500K	1.000
	4000K	1.027
	5000K	1.054
90	2700K	0.784
	3000K	0.847
	3500K	0.874
	4000K	0.946

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LSS - Semi Specular	1.00
LD - Matte Diffuse	0.98
Reflector Color	**Multiplier**
WR - White	0.98
BR - Black	0.92
BZR - Bronze	0.91
AR - Clear	1.00
GR - Gold	0.99
PR - Pewter	0.99
WTR - Wheat	0.98

Driver		Control Provided				
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIREM2	NLTAIRER2
UGZ	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations	
		SGB	RGH
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep (by others)	✓	✗
	4" Octagonal 4x4x2.125 deep (by others)	✓	✗
	Factory Provided Gear Box (4" Square 4x4x1.5 deep)	✗	✓

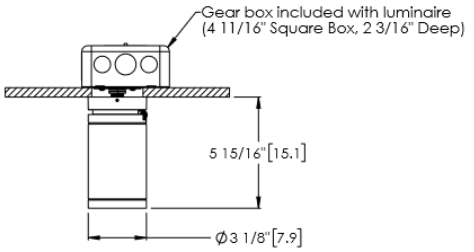
Standard Architectural Color Options for Cylinder Bodies

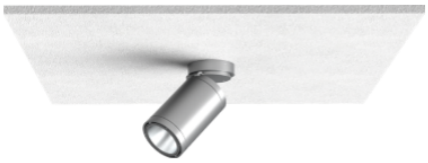
NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please always contact a Gotham representative for an accurate paint chip sample.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

DIMENSIONAL DATA

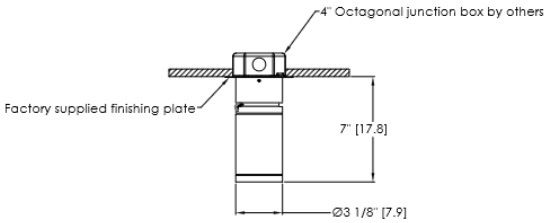
RGH - Recessed Gear Housing



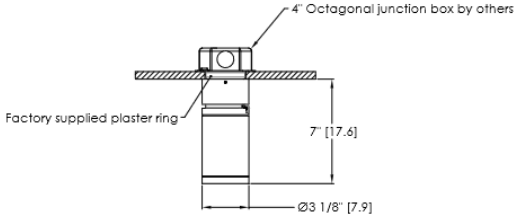


Ceiling cutout: Ø2 3/4" [7]
Ceiling thickness range: 3/8" [1.0] to 3" [7.6]

SGB - Surface Gear Box



SGBPR - Surface Gear Box with Plaster Ring

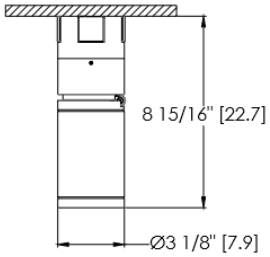


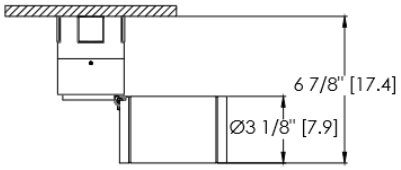
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

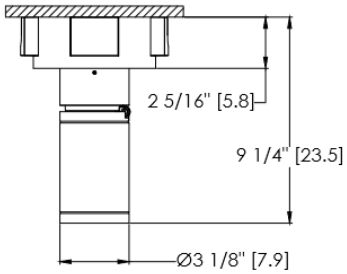
DIMENSIONAL DATA

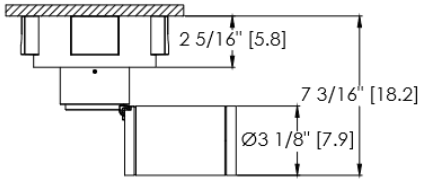
SGBCC - Direct Conduit Surface Gear Box

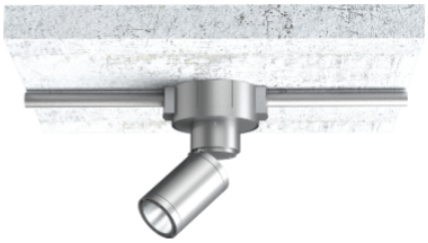




JBXCC - Surface J-Box with Conduit Covers





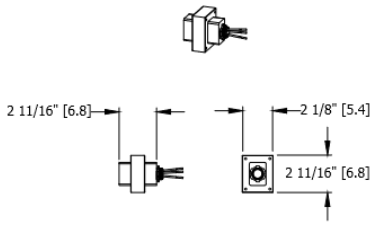


*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

DIMENSIONAL DATA

347V Transformer



347 Transformer:
Install to accessible
junction box by others

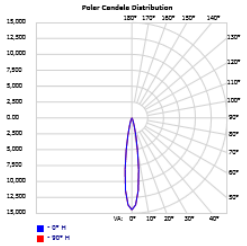
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

PHOTOMETRY

15D 15 Degree Beam

ICO2 35/15 AR LSS 15D



Wattage: 19.8, Lumens: 1647.1, LPW: 83, S/MH: .29, Test No: 19-383-01P929

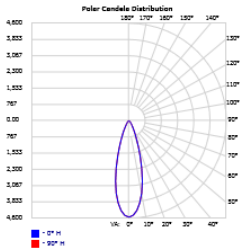
Candela Summary	
0°	14453
10°	5106
20°	606
30°	161
40°	62
50°	18
60°	3
70°	1
80°	0
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1541	93.6%
0-40	1607	97.6%
0-60	1644	99.8%
0-90	1647	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	225.84	2.3	2.3
10'	144.53	2.9	2.9
12'	100.37	3.5	3.5
14'	73.74	4.1	4.1
16'	56.46	4.7	4.7

30D 30 Degree Beam

ICO2 35/15 AR LSS 30D



Wattage: 19.8, Lumens: 1568.3, LPW: 79, S/MH: .51, Test No: 19-383-04P929

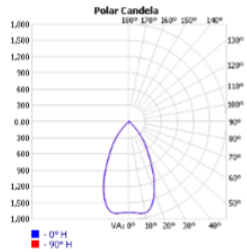
Candela Summary	
0°	4553
10°	3471
20°	1303
30°	364
40°	138
50°	39
60°	6
70°	2
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1343	85.6%
0-40	1483	94.5%
0-60	1563	99.7%
0-90	1568	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	71.14	4.4	4.4
10'	45.53	5.5	5.5
12'	31.62	6.5	6.5
14'	23.23	7.6	7.6
16'	17.79	8.7	8.7

55D 55 Degree Beam

ICO2 35/15 AR LSS 55D



Wattage: 19.8, Lumens: 1585, LPW: 80, S/MH: .91, Test No: 19-383-09P929

Candela Summary	
0°	1675
10°	1715
20°	1373
30°	752
40°	348
50°	51
60°	6
70°	2
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1090	68.8%
0-40	1424	89.9%
0-60	1580	99.7%
0-90	1585	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	26.17	8.6	8
10'	16.75	10.7	10
12'	11.63	12.9	12
14'	8.54	15	14
16'	6.54	17.2	16

CRI/CCT Multiplier Table		
CRI	CCT	Multiplier
80	2700K	0.93
	3000K	0.96
	3500K	1.00
	4000K	1.02
	5000K	1.04
90	2700K	0.81
	3000K	0.84
	3500K	0.87
	4000K	0.91

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

NLIGHT

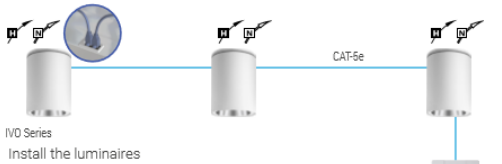
nLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Controls



1. Install the luminaires
2. Install the nLight Wired wall switch
3. Connect the luminaires using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Controls

1. Install the luminaires
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY+ mobile app to pair the fixtures with the wall switch and if desired, customize the sensor settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	ICO2STRC-30/20-AR-LSS-40D-MVOLT-UZG-SGB-DBL
TOTAL WATTS	28.55
VOLTAGE	MVOLT
MOUNTING	Surface
WEIGHT	
DIMENSIONS	3.125 x 3.125 x 6
FINISH	Matte Black
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2000
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

Surface mount adjustable cylinder with one (1) LED lighting source, 2000 delivered lumens, 3000K color engine, 80+ CRI, 40° optic and remote driver. Cylinder should operate on MVOLT voltage and be supplied with a 0-10v control option down to 1% with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Cylinder to have matte black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

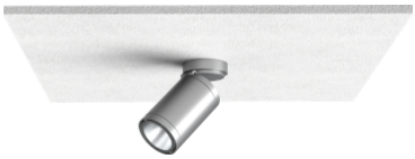
gotham | INCITO®

Luminaire Type:

Catalog Number:

BAA BABA nLIGHT

High Center Beam Tilt/Rotate Surface Ceiling Cylinder 2"

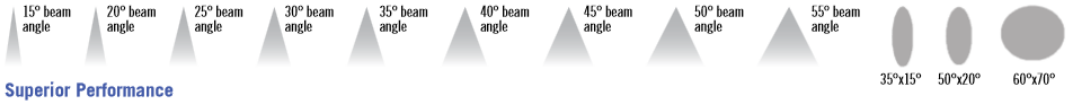


OVERVIEW

Feature Set

- Adjustable tilt (90°) and rotation (365°)
- Thirteen optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 50° Cutoff to source and source image
- Field interchangeable optic
- Surface mounted or recessed mounted driver options
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling (WL option) available
- 20 standard colors in textured and gloss finish; custom & RAL colors also available

Distribution



Superior Performance

Nominal Lumens	02LM	05LM	07LM	10LM	15LM	20LM
Delivered Lumens	284	543	813	1093	1647	2112
Wattage	3.13	5.55	8.48	11.93	19.8	28.55
Lumens per Watt	91	98	96	92	83	74

*Based on 3500K AR LSS 15D 80CRI

MULTIPLE LAYERS OF LIGHT

Incito & EVO Product Families | Building Layers of Light

High Center Beam Layer | Incito

General Illumination Layer | EVO

EVO + Incito — Multiple Layers of Light

Visit: Core | Special Applications | Healthcare

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham INCITO®

2" High Center Beam Tilt/Rotate Surface Ceiling Cylinder

Luminaire Type:

Catalog Number:

ORDERING INFORMATION

EXAMPLE: ICO2STRC 35/10 AR LSS 20D MVOLT UGZ RGH DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Beam	
ICO2STRC	Incito 2in Round Surface Ceiling Tilt/ Rotate Cylinder Open Downlight	27/	2700 K	02	250 lumens	AR	Clear	LSS	Semi-specular	15D	15° beam angle
		30/	3000 K	05	500 lumens	PR	Pewter	LD	Matte diffuse	20D	20° beam angle
		35/	3500 K	07	750 lumens	WTR	Wheat			25D	25° beam angle
		40/	4000 K	10	1000 lumens	GR	Gold			30D	30° beam angle
		50/[1]	5000 K	15	1500 lumens	WR[2]	White painted			35D	35° beam angle
				20	2000 lumens	BR[2]	Black painted			40D	40° beam angle
						BZR[2]	Dark Bronze painted			45D	45° beam angle
										50D	50° beam angle
										55D	55° beam angle
										3515D	Elliptical 35° x 15° beam angle
										5020D	Elliptical 50° x 20° beam angle
										6070D	Elliptical 60° x 70° beam angle

Voltage		Driver		Mounting		Control Interface[5]	
MVOLT	120V - 277V	UGZ[3]	Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	RGH[4]	Recessed Gear Housing	(blank)	
120	120V			SGB	Surface Gear Box	NLT	Embedded wired controls by nLight
277	277V			SGBPR	Surface Gear Box with Concealed Plaster Ring	NLTER[6]	Embedded wired controls by nLight with UL924 listed emergency operation
				SGBCC	Direct Conduit Surface Gear Box	NLTAIR2	Embedded wireless controls by nLight
				JBXCC	Surface J-Box with Conduit Covers	NLTAIRER2[6]	Embedded wireless controls by nLgiht with UL924 listed emergency operation via power sense leads
						NLTAIREM2	Embedded wireless controls by nlight with UL924 listed emergency operation

Options		Architectural Colors - Powder Paint[9]			
90CRI[1]	High CRI (90+)	DDB	Gloss Dark Bronze	DDBT	Textured Dark Bronze
N80[7]	nLight Lumen Compensation	DBL	Matte Black	DBLB	Textured Black
WL[8]	Wet Location	DWH	Gloss White	DWHG	Textured White
		DMB	Matte Medium Bronze	DBNH	Textured Bronze
		DNA	Gloss Natural Aluminum	DNAT	Textured Natural Aluminum
		DSS	Gloss Sandstone	DSST	Textured Sandstone
		DGC	Gloss Charcoal Grey	DSPD	Textured Dark Grey
		DTG	Gloss Tennis Green	DSPE	Textured Green
		DBR	Gloss Bright Red	DSPH	Textured Light Red
		DSB	Gloss Steel Blue	DWHAMF	Gloss White with Anti-microbial finish

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes.
ICO2OPTC XXD	Additional optics for field installation. Replace "XX" with beam angle.
ICO2OPTC KIT	Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns
HS234FL	Hole saw for RGH option
SDT 347/120 75VA	347V/120V, 75VA step down transformer. Must be remote mounted.

ORDERING NOTES

1. 5000K CCT not available with 90CRI.
2. Not available with Reflector Finish.
3. Refer to Tech 240 for compatible dimmers.
4. RGH with 2000LM option requires 120 or 277 (non-IC).
5. Field installed. Access required to location of remote mounted device.
6. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
7. Requires NLT or NLTER.
8. Not available with SGBCC or JBXCC.
9. For details on RAL and Custom colors please see Architectural colors.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

SPECIFICATIONS

Optical and Trim Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 50° cutoff to source and source image. Top down flash characteristic for superior glare control.

Superior 100% Virgin-silicone refractive optic, enables maximum dimensional stability and optical transmission with no discoloration over life. Field inter-changeable optics.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted step-down transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages. THD @ Full Load is >20%. Inrush current meets NEMA-410 requirments. Surge Protection +/- 1kV DM, +/- 2kV CM.

Controls

Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 1.0% of rated lumen output with a smooth shut off function to step to 0%.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Surface Gear Box (SGB) for direct installation to 4" recessed or surface octagonal (by others).

Recessed Gear Housing (RGH) ships with driver box for recessed or surface installation.

Die cast with flangeless reflector allows flow-through passive thermal management.

Accommodates between 3/8" to 3"-thick ceilings.

Listings

Fixtures are UL Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location covered ceiling optional (WL).

RGH option is IC rated up to 1500LM

Government Procurement

BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act Please refer to www.acuitybrands.com/buy-american for additional information

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Warranty

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

TABLES OF USE

Lumen Output Multiplier		
CRI	CCT	Multiplier
80	2700K	0.910
	3000K	0.946
	3500K	1.000
	4000K	1.027
	5000K	1.054
90	2700K	0.784
	3000K	0.847
	3500K	0.874
	4000K	0.946

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LSS - Semi Specular	1.00
LD - Matte Diffuse	0.98
Reflector Color	**Multiplier**
WR - White	0.98
BR - Black	0.92
BZR - Bronze	0.91
AR - Clear	1.00
GR - Gold	0.99
PR - Pewter	0.99
WTR - Wheat	0.98

Driver		Control Provided				
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIREM2	NLTAIRER2
UGZ	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations	
		SGB	RGH
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep (by others)	✓	✗
	4" Octagonal 4x4x2.125 deep (by others)	✓	✗
	Factory Provided Gear Box (4" Square 4x4x1.5 deep)	✗	✓

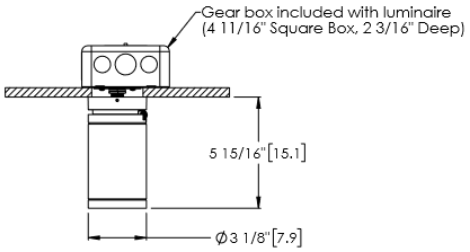
Standard Architectural Color Options for Cylinder Bodies

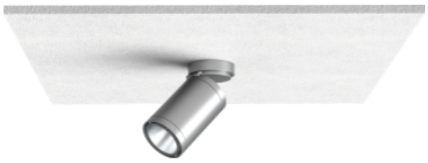
NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please always contact a Gotham representative for an accurate paint chip sample.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

DIMENSIONAL DATA

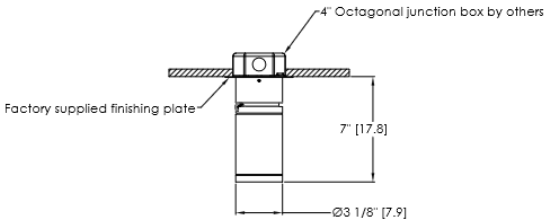
RGH - Recessed Gear Housing



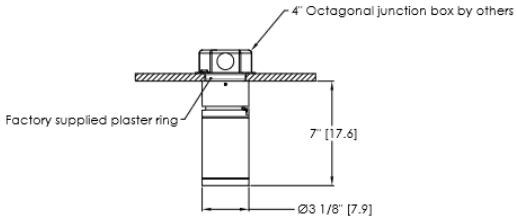


Ceiling cutout: Ø2 3/4" [7]
Ceiling thickness range: 3/8" [1.0] to 3" [7.6]

SGB - Surface Gear Box



SGBPR - Surface Gear Box with Plaster Ring

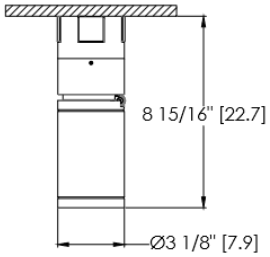


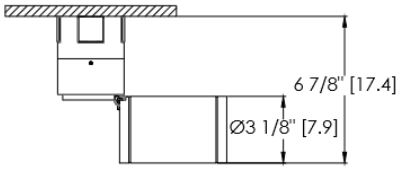
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

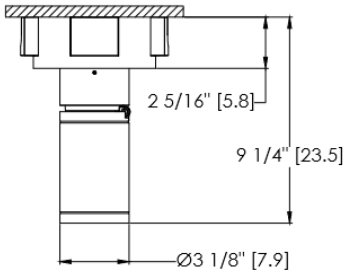
DIMENSIONAL DATA

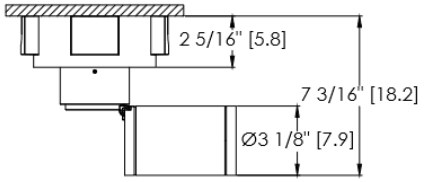
SGBCC - Direct Conduit Surface Gear Box

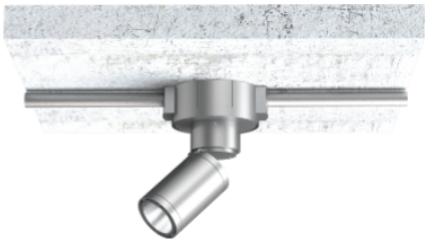




JBXCC - Surface J-Box with Conduit Covers





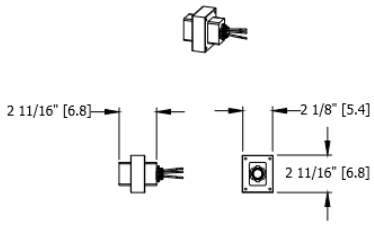


*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

DIMENSIONAL DATA

347V Transformer



347 Transformer:
Install to accessible
junction box by others

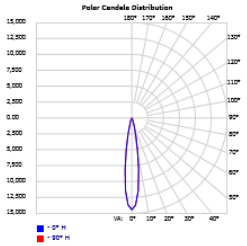
*Dimensions in inches [centimeters]

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

PHOTOMETRY

15D 15 Degree Beam

ICO2 35/15 AR LSS 15D



Wattage: 19.8, Lumens: 1647.1, LPW: 83, S/MH: .29, Test No: 19-383-01P929

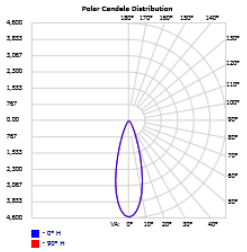
Candela Summary	
0°	14453
10°	5106
20°	606
30°	161
40°	62
50°	18
60°	3
70°	1
80°	0
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1541	93.6%
0-40	1607	97.6%
0-60	1644	99.8%
0-90	1647	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	225.84	2.3	2.3
10'	144.53	2.9	2.9
12'	100.37	3.5	3.5
14'	73.74	4.1	4.1
16'	56.46	4.7	4.7

30D 30 Degree Beam

ICO2 35/15 AR LSS 30D



Wattage: 19.8, Lumens: 1568.3, LPW: 79, S/MH: .51, Test No: 19-383-04P929

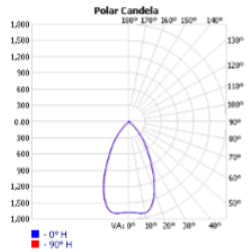
Candela Summary	
0°	4553
10°	3471
20°	1303
30°	364
40°	138
50°	39
60°	6
70°	2
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1343	85.6%
0-40	1483	94.5%
0-60	1563	99.7%
0-90	1568	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	71.14	4.4	4.4
10'	45.53	5.5	5.5
12'	31.62	6.5	6.5
14'	23.23	7.6	7.6
16'	17.79	8.7	8.7

55D 55 Degree Beam

ICO2 35/15 AR LSS 55D



Wattage: 19.8, Lumens: 1585, LPW: 80, S/MH: .91, Test No: 19-383-09P929

Candela Summary	
0°	1675
10°	1715
20°	1373
30°	752
40°	348
50°	51
60°	6
70°	2
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1090	68.8%
0-40	1424	89.9%
0-60	1580	99.7%
0-90	1585	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	26.17	8.6	8
10'	16.75	10.7	10
12'	11.63	12.9	12
14'	8.54	15	14
16'	6.54	17.2	16

CRI/CCT Multiplier Table		
CRI	CCT	Multiplier
80	2700K	0.93
	3000K	0.96
	3500K	1.00
	4000K	1.02
	5000K	1.04
90	2700K	0.81
	3000K	0.84
	3500K	0.87
	4000K	0.91

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

NLIGHT

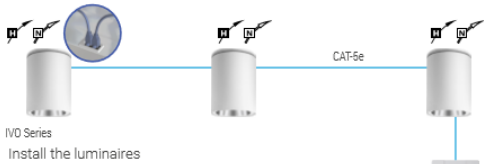
nLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Controls



1. Install the luminaires
2. Install the nLight Wired wall switch
3. Connect the luminaires using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Controls

1. Install the luminaires
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY+ mobile app to pair the fixtures with the wall switch and if desired, customize the sensor settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2021-2024 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 10/01/24 Specifications subject to change without notice.
The product images shown are for illustration purposes only and may not be an exact representation of the product.

EQUIPMENT

MANUFACTURER	RBW Dimple Sconce
CATALOG NUMBER	DP-WS-S3-AA04-27-0.1-10W-UNV-IP20
TOTAL WATTS	8.5
VOLTAGE	120
MOUNTING	Wall
WEIGHT	3LBS
DIMENSIONS	3.3″ x 5″ x 5″
FINISH	Amber Glass; Black anodized backplate
RATING	IP65
LISTING	UL

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	2700K
CRI	90+
LUMEN OUTPUT	217
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Decorative Wall mount fixed sconce with one (1) LED lighting source, 217 delivered lumens, 2700K color engine, 90+ CRI and integral driver. Sconce should operate on 120 voltage and be supplied with a 0-10v control option. Sconce to have amber glass; black anodized backplate finish finish. Sconce to be rated for IP65 or equivalent. Sconce should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Dimple Sconce

Sconces

YOUR PRODUCT CODE

DP-WS-S3-AA04-27-0.1_10V_UNV-IP20

DESCRIPTION

Dimple is a compact and flush-mounted sconce that casts a diffuse and soft, atmospheric light. It is cheekily named for the thick, domed circular diffuser embedded into its front face.

MATERIALS

Cast solid glass, aluminum

COLLECTION NOTES

Luminaire lumens listed are for AC input TRIAC control. DC input performance please see photometry downloads. Each form of cast glass is unique. We review each to ensure they conform to ASTM standards, which includes the presence of small air bubbles within the glass.

PRODUCT DIMENSIONS

5 in dia x 3.3 in D

PRODUCT WEIGHT

3 lbs / 1.6 kg

PERFORMANCE

Delivered Lumens 278 lm (Frosted) | 237 lm (White) | 122 lm (Smoked) | 217 lm (Amber)
Power Consumption 8.5W
Luminous Efficacy 38.3 lm/W (Frosted) | 32.7 lm/W (White) | 16.9 lm/W (Smoked) | 29.1 lm/W (Amber)
95 CRI (Smoked) 90 CRI (Frosted/White) 80 CRI (Amber)
Full detail in photometry summary

CERTIFICATION

ADA Compliant
UL Listed
UL Listed to Canadian safety standards.
Suitable for Wet Locations
Suitable for Damp Locations
IP20
IP65
Declare (LBC Red List Approved)

Declare.

LED LIFESPAN

50k hours

SPECIFICATION LOGIC

GLASS FINISH

White Interior	S1
Smoked	S2
Amber	S3
Frosted	S4

BACKPLATE FINISH

Natural Anodized	AA01
Black Anodized	AA04

COLOR TEMPERATURE

2700K (warm white)	27
3000K (soft white)	30
3500K (neutral white)	35

DIMMING / CONTROL / INPUT

10% Dimming, TRIAC / Forward Phase Control, 120V Input	10_TRIAC_120V
1% Dimming, TRIAC / Forward Phase Control, 120V Input (Driver External)	1_TRIAC_120V
1% Dimming, 0-10V Control, 120V or 277V "Universal Input" (Driver External)	1_10V_UNV
0.1% Dimming, 0-10V Control, 120V or 277V "Universal Input" (Driver External)	0.1_10V_UNV
Low Voltage (Driver required, driver not included)	LV

IP RATING

IP 20	IP20
IP 65	IP65

DRAWINGS

DP-WS Dimple Sconce Dimension

EQUIPMENT

MANUFACTURER	Trans Globe Lighting
CATALOG NUMBER	22300 AG
TOTAL WATTS	16
VOLTAGE	120
MOUNTING	Wall
WEIGHT	
DIMENSIONS	3.3" x 4.7" x 6"
FINISH	Antique Gold
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	Bulbrite
CATALOG NUMBER	LED7G25/30K/FIL/D/B/2
QUANTITY	2
CCT	3000
CRI	80+
LUMEN OUTPUT	800
ANTICIPATED LIFE	15000

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES

Wall mount fixed sconce with two (2) LED lighting sources each, 800 delivered lumens, 3000 color engine, 80+ CRI, 300° optic. Sconce should operate on 120 voltage and be supplied with a line voltage dimmer control option and include a minimum 2-year warranty with a 15000 hour anticipated life. Sconce to have antique gold finish. Sconce should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	Dimming

NOTES

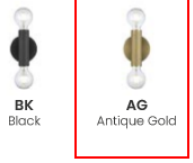
Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

TRANSGLOBE LIGHTING
(818) 768-5511
(800) 446-9092
hello@tglighting.com
USA

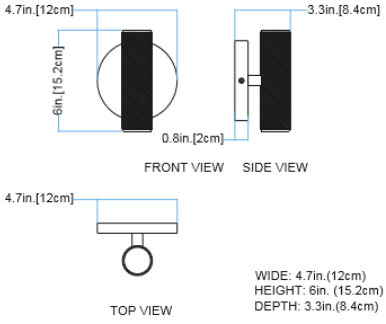
Job Type :
Job Name :
Company :
Quantity :

22300 Auburn

B53
22300 AG



Finish	Polished Chrome
Finish Code	PC
Fixture Dimensions	4.7W x 6.0MH x 3.3D
Bulb Type	Medium base (E-26)
Number of bulbs	2
Bulbs included	No
Wattage	120
Voltage	120
Location Rating	Damp
Dimmable	Yes
Mounting	Horizontally and Vertically



BULBRITE
turn life on

TECHNICAL SPECIFICATION SHEET

Filaments

7W LED G25 3000K FILAMENT E26 DIM

Item# 776219

Ordering Code LED7G25/30K/FIL/D/B/2

UPC 739698762197

- G25 LED bulb with an E26, medium screw, base in a Clear finish.
- 60 Watt equivalent, using only 7.6 Watts (800 lumens).
- 3000K color temperature for a Soft White light.
- Fully Dimmable and works with most dimmer switches.
- Damp Rated for use in indoor / outdoor (not directly exposed to water) locations.
- Long lasting energy efficient LED lighting, lasts up to 15,000 hours.
- 2 Year Limited Warranty
- 2 year Limited Warranty

Width	Height	Length
3.270 in	5.310 in	3.270 in

Technical Specifications			
Avg Hours	15000	Inner Carton UPC	10739698762194
Base	E26	Item #	776219
Bulb Type	G25	Lumens	800
CBCP	0	M.O.D	3.150 in
CCT Color	3000K	M.O.L	4.720 in
Color	Soft White Light	Outer Carton Qty	40
CRI	80	Outer Carton UPC	40739698762195
Dimmable	Y	Safety Rated	UL
Enclosed Rated	Y	Safety Rating Type	DAMP
Energy Star	N	Title 20	N
Equivalent	60	Title 24	N
Finish	Clear	Volts	120
Individual Qty	1	Warranty Years	2
Individual UPC	739698762197	Watts	7.6
Inner Carton Qty	0		

NEW JERSEY | SOUTH CAROLINA | TEXAS

800-528-5555 - SERVICE@BULBRITE.COM - BULBRITE.COM

EQUIPMENT

MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	VC150IM12
TOTAL WATTS	4.5
VOLTAGE	120
MOUNTING	Wall
WEIGHT	2 lb
DIMENSIONS	4.5" x 4.5" x 9"
FINISH	Gray
RATING	IP
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	Sunlite
CATALOG NUMBER	81080-SU A19/LED/FS/4.5W/TB/2PK
QUANTITY	1
CCT	Blue
CRI	
LUMEN OUTPUT	55
ANTICIPATED LIFE	15000

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES

Wall mount fixed sconce with one (1) LED lighting source, 55 delivered lumens, Blue color engine, 320° optic. Sconce should operate on 120 voltage and be supplied with a line voltage dimmer control option and include a minimum 2-year warranty with a 15000 hour anticipated life. Sconce to have gray finish. Sconce should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

B56

LITHONIA LIGHTING®

Catalog Number	VC150IM12
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE

Utility wall-, ceiling- or pendant-mounted fixtures for entrances, hallways, closets, tunnels or other utility applications. Incandescent, fluorescent, metal halide or high pressure sodium sources are available.

CONSTRUCTION

Rugged die-cast aluminum housing with heavy-duty glass globe. 3/4" threaded knockouts allow for side or top conduit entry. Gray finished.

Designed for easy installation and maintenance.

Prismatic globe for even distribution.

Junction box included

LISTINGS

Listed and labeled to UL standards for wet locations.
Listed and labled to CSA standards.

WARRANTY

2-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
Specifications subject to change without notice.

Utility Vapor Tights

VC

VW

Specifications

All dimensions are inches (centimeters) unless otherwise indicated.

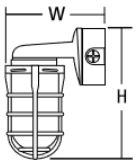
Ceiling

VC150I

Height: 9 (22.9)
Width: 4-1/2 (11.4)

Wall

VW150I



Height: 10 (25.4)
Width: 7-1/4 (18.4)

ORDERING INFORMATION

Catalog Number	UPS	Description	Lamp Wattage	Source	Lamp Voltage	Lamp Included	Pallet (lbs)	Standard Carton Qty	Qty
VC150I M12	745973817704	Ceiling mount	150	Incandescent	120	N	2	288	12
VW150IM12	745973817681	Wall Mount	150	Incandescent	120	N	2	192	12

OUTDOOR: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

© 2009-2021 Acuity Brands Lighting, Inc. All rights reserved. Rev 09/02/21

sunlite

Catalog # **81080-SU**
A19/LED/FS/4.5W/TB/2PK

A Series

Sunlite 81080 LED Colored Filament A19 Light Bulb, 4.5 Watts, 55 Lumens, Medium E26 Base, 120 Volts, Transparent Blue, Dimmable, 320 Degrees Beam Angle, UL Listed, 2 Count

Filament Colored Series

DESCRIPTION:

Illuminate your space with a splash of color and a touch of elegance using the Sunlite LED Colored Filament A19 Light Bulb. With a common A19 shape and medium (E26) base they can be used to upgrade any standard fixture or lamp in your home or business. With a power consumption of only 4.5 watts, this LED bulb is an energy-efficient choice, helping you save on your electricity bills without compromising on the brightness. Built to last, it has an impressive average rated lifespan of 15,000 hours. UL Listed to meet strict safety and quality standards, assuring you of its reliability and durability. Rated for totally enclosed fixtures. Dimensions 4" L x 2.35" D.

FEATURES:

- *VIBRANT LIGHT - Emitting a rich and vibrant light, this bulb is designed to add a splash of color to any room or event, enhancing the aesthetic appeal. With a common A19 shape and medium (E26) base they can be used to upgrade any standard fixture or lamp in your home or business. They remain cool to the touch even when in use.*
- *ENERGY EFFICIENT - With a power consumption of only 4.5 watts, this LED bulb is an energy-efficient choice, helping you save on your electricity bills without compromising on the brightness. It provides extensive lighting coverage, illuminating your space uniformly and beautifully thanks to its 320-degree beam angle.*
- *LONG LIFE LED - Built to last, it has an impressive average rated lifespan of 15,000 hours, ensuring that you enjoy sustained lighting without the need for frequent replacements.*
- *DIMMABLE - This bulb comes with a dimmable feature, allowing you to adjust the light intensity according to your mood or the setting, creating the perfect ambiance.*
- *SAFETY & QUALITY - UL Listed to meet strict safety and quality standards, assuring you of its reliability and durability. Rated for totally enclosed fixtures. Dimensions 4" L x 2.35" D.*

744 Clinton Street Brooklyn, NY, 11231 | 718.768.7000 Sunlite.com

sunlite

Catalog # **81080-SU**
A19/LED/FS/4.5W/TB/2PK

SPECIFICATIONS:

General Characteristics

Bulb Shape	A19
Nanometer	476-495NM
Average Rated Hours	15000
Finish	Blue
Base	Medium Screw (E26)
Average Life Span Years	14
Dimmable	Yes
Material	Glass

Electrical Characteristics

Watts	4.5
Volts	120
LED Chip Manufacturer	24T38Q714
Power Factor	0.9
Temperature	-20° to 40° C

Light Characteristics

Lumens Brightness	55
Emitted Color	Blue
Beam Angle	320°

Additional Features

Safety Rating Mark	UL Listed - Damp Location
UL Rated Enclosed Fixtures	Yes

Product Dimensions

MOL (in)	4
Diameter (in)	2.35
Package Dimension (in)	(W) 2.6 (H) 4.5 (D) 5
Package Weight (lb)	0.170

Product Data

Case Unit Rate	3
Pack Size	2
Item UPC	653703810805
Warranty Years	2
Package Type	Box

744 Clinton Street Brooklyn, NY, 11231 | 718.768.7000 Sunlite.com

EQUIPMENT

MANUFACTURER	IBM Illuminated Mirrors
CATALOG NUMBER	CHICR32323000 - BLK
TOTAL WATTS	35.5
VOLTAGE	110
MOUNTING	Wall
WEIGHT	26
DIMENSIONS	32" x 1.9" x 32"
FINISH	Black
RATING	IP44
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	4140
ANTICIPATED LIFE	120000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Wall mount fixed self illuminated mirror with one (1) LED lighting source, 4140 delivered lumens, 3000K color engine, 90+ CRI, 270° optic and integral driver. Self Illuminated Mirror should operate on 110 voltage and be supplied with a line voltage dimmer control option with a 120000 hour anticipated life. Self illuminated mirror to have black finish. Self Illuminated Mirror to be rated for IP44 or equivalent. Self Illuminated Mirror should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

PARIS MIRROR

PRODUCT SPECIFICATION
SKU :CHICR32323000 / 6000 / CCT / RGBW - BLK

CHIC ROUND

FRONT-LIT MIRROR
32 X 32 IN

IBM Illuminated Mirrors
CHICR32323000 - BLK

c UL us LISTED

FEATURES AND BENEFITS

- LED TECHNOLOGY
- HANGS VERTICALLY
- ENERGY EFFICIENT
- CRI 90+
- DIMMABLE WITH ANY STANDARD MLV/ TRIAC DIMMER WALL SWITCH
- UL CERTIFIED
- DURABLE (UP TO 120 000 HOURS)
- 5 YEARS WARRANTY

AVAILABLE OPTIONS

- 6000K LED
- 3000K LED
- CCT LED 2700-6000K
- RGBW LED

LIGHTING SPECIFICATION

- DIMENSIONS : 32X32 in
- WEIGHT : 26 POUNDS (LBS)
- IP RATING: 44
- INPUT VOLTAGE: 110V
- CRI: 90+

SAFETY SPECIFICATION

- ENTIRE ASSEMBLY MEETS UL/cUL STANDARDS
- INTERNATIONAL CERTIFICATIONS
- SAFETY - BACKED MIRROR

PARIS MIRROR

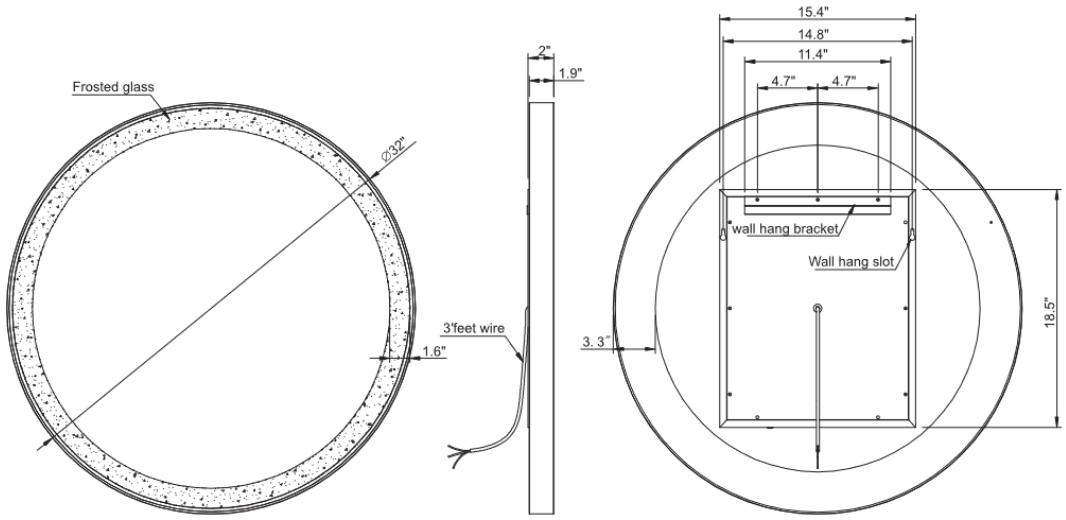
PRODUCT SPECIFICATION
SKU :CHICR32323000 / 6000 / CCT / RGBW - BLK

CHIC ROUND

FRONT-LIT MIRROR
32 X 32 IN

MODELS :

Base model	*Kelvin temperature*	*Dimensions*	*Lumens*	*Power requirements*
CHICR32323000-BLK	3000K	32"W x 32"H x 2"D (813mm x 813mm x 49mm)	4140	110 VAC , 35.5w
CHICR32326000-BLK	6000K	32"W x 32"H x 2"D (813mm x 813mm x 49mm)	4250	110 VAC , 35.5w
CHICR3232CCT-BLK	CCT	32"W x 32"H x 2"D (813mm x 813mm x 49mm)		110 VAC
CHICR3232RGBW-BLK	RGBW	32"W x 32"H x 2"D (813mm x 813mm x 49mm)		110 VAC



FRONT VIEW RIGHT SIDE REAR VIEW

INSTALLATION & AFTER CARE INSTRUCTIONS:

- 110V HARD WIRED ELECTRICAL CONNECTION
- Z BAR INCLUDED
- MIRROR SHOULD BE CONTROLED BY AN ON/OFF WALL SWITCH
- INSTALLATION WIRING MAY BE DIFFERENT WITH MIRRORS EQUIPPED WITH ADDITIONAL OPTIONS.

PARIS MIRROR

PRODUCT SPECIFICATION
SKU :CHICR32323000 / 6000 / CCT / RGBW - BLK

CHIC ROUND

FRONT-LIT MIRROR
32 X 32 IN

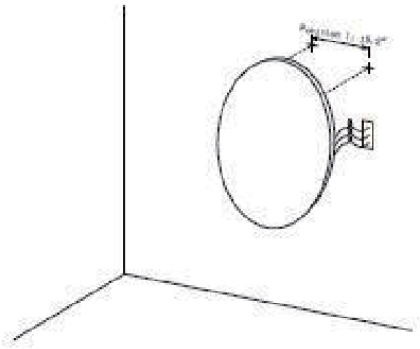
INSTALLATION & AFTER CARE INSTRUCTIONS:

Installation:
All Paris Mirror backlit and LED mirrors have been independently tested for compliance with electrical equipment (safety) regulations.
All illuminated and backlit mirrors are IP44 rated.
Illuminated mirrors have been designed and independently tested for compliance to electrical equipment (safety) regulations, and are UL Certified.
LEDs have a life expectancy of 120,000 hours of continuous use. All LED light fittings are replaceable and are available through Paris Mirror customer service.

IMPORTANT: Always switch off the electrical supply at the mains during installation and maintenance. It is recommended that fuse
is withdrawn or circuit breaker switched off before installation begins.
Fitting in Bathrooms is subject to all regulations. It is not suitable for product installations in Saunas, Steam Rooms, or shower cubicles,and it is recommended for permanent installation.

Care Safety:
Wear suitable eye wear protection when drilling. Use caution when using power tools near water, beware of hidden cables or pipes.
Take care if drilling on tiled surfaces in case the drill slips. A piece of masking tape applied to wall before marking out fixing holes
will stop drill from moving.

Cleaning & Maintenance:
It is recommended that the unit is cleaned with a soft, dry, non-abrasive cloth when turned off.
Never use cleaning agents or abrasive
material on any type of surface finish.
Do not strike glass components with hard or pointed items.
Do not place very hot or cold items against or close proximity to glass surfaces.



120V DIMMABLE LED DRIVER INCLUDED

1- Decide on wall positional placement.
2- Prepare & install wall hooks measured to distance between mirror's anchors.
3- Match & attach 3 electrical wires from mirror to home electrical wires:
Live to Live, Ground to Ground, Neutral to Neutral.
4- Hang and affix to wall.

EQUIPMENT

MANUFACTURER	Visa
CATALOG NUMBER	OW2484-L30K(H)-MVOLT-FT-BRNZ
TOTAL WATTS	60
VOLTAGE	MVOLT
MOUNTING	Surface
WEIGHT	
DIMENSIONS	72" x 2.5" x 2.5"
FINISH	Bronze
RATING	IP65
LISTING	ETL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	4100
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

Surface mount fixed linear with one (1) LED lighting source, 4100 delivered lumens, 3000K color engine, 80+ CRI, forward throw optic and remote driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option down to 1%. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Linear to have bronze finish. Mullion mount. Linear to be rated for IP65 or equivalent. Linear should be ETL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Rev: 2023/08/03

OW2484 PASSAGE™

Mullion Mount with Remote Power Supply

VISA LIGHTING

Visalighting.com/products/Passage

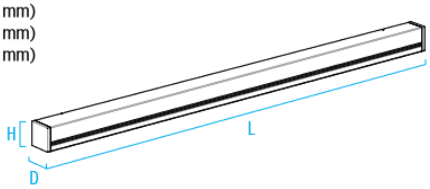
Type: Project: Location:

DIMENSIONS

Depth is measured from wall to front of fixture

L = Length H = Height D = Depth

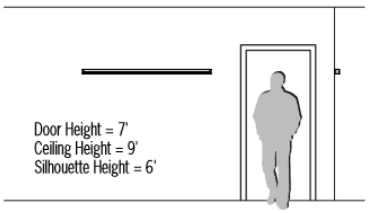
L	72"	(1829 mm)
H	2-1/2"	(64 mm)
D	2-1/2"	(64 mm)



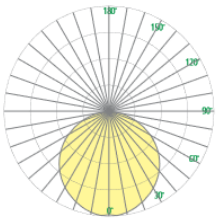
FEATURES

- High or low lumen output
- Luminous or Forward Throw output
- Modular design for replacement of LED source or driver
- Remote power supply included (suitable for indoor, Type IC)
- Optional dual circuit switching
- IP65 rated
- Bracket mounting system simplifies installation and maintenance
- Window mullion mount; minimum mullion width 2.5"
- Tamper resistant fasteners
- Polycarbonate diffuser
- No VOC powder coat paint finish; metal based sublimated wood look finish
- ETL Listed for wet location mounting 4' above grade

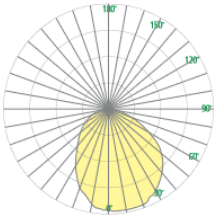
RELATIVE SCALE DRAWING



PHOTOMETRICS



LUM (Luminous Lens)



FT (Forward Throw Optic)

IP65 ADA Compliant ETL Listed 5 Year Warranty

Visual Terrain® www.visualterrain.net		PROJECT: Bentonville Ballroom CLIENT: Live Nation SUBMISSION: 100% Detail Design DOCUMENT #:	EQUIPMENT TYPE
DATE: 10/23/2026	REVISION #		B90
PAGE 73 OF 505	0	Equipment Page 2 of 4	

OW2484 PASSAGE (cont.)

Mullion Mount with Remote Power Supply

VISA LIGHTING

Fill in shaded boxes using information listed below

OW2484		–	MVOLT			
MODEL	SOURCE[1] L30K(H) L30K(L) L35K(H) L35K(L) L40K(H) L40K(L)		VOLTAGE MVOLT	OPTIC[2] LUM FT	FINISH See last page for finish order codes	OPTION[3] DS

SOURCE[1] (Select one)

Dimmable 0-10V to 1%, Minimum 82CRI, within 3-step MacAdam

Source	CCT	Delivered Forward Throw Lumens	Delivered Luminous Lumens	Power (Watts)
L30K(H)	3000K	4100	2900	60
L30K(L)	3000K	1800	1300	27
L35K(H)	3500K	4100	2900	60
L35K(L)	3500K	1800	1300	27
L40K(H)	4000K	4100	2900	60
L40K(L)	4000K	1800	1300	27

VOLTAGE

MVOLT	120-277V, 50/60 Hz

OPTIC[2] (Select one)

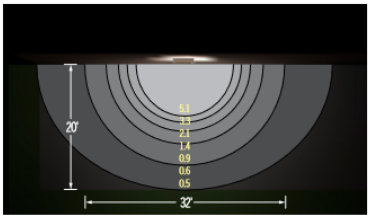
LUM	Luminous Lens
FT	Forward Throw Optic

OPTION[3]

⚠ Option availability may be interdependent with Other Options

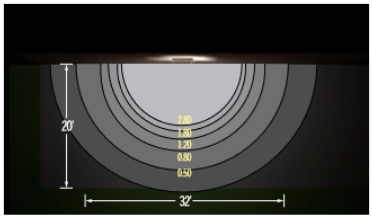
DS	Dual circuit switching (includes 2 drivers). Lumen output and wattage is split in half for each circuit

PATH OF EGRESS - LUMINOUS LENS



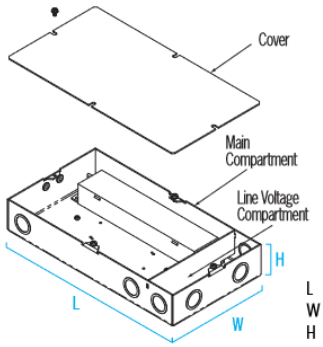
OW2484 –H Downlight, Mounted at 10' AFF, .70 light loss factor used

PATH OF EGRESS - FORWARD THROW



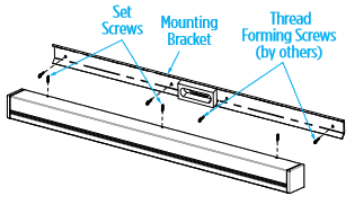
OW2484 –H Downlight, Mounted at 10' AFF, .70 light loss factor used

REMOTE POWER SUPPLY ENCLOSURE



L	12"	(305 mm)
W	6-3/8"	(162 mm)
H	2"	(51 mm)

MULLION MOUNTING DETAIL



OW2484 PASSAGE (cont.)

Mullion Mount with Remote Power Supply

VISA LIGHTING

PASSAGE PRODUCT FAMILY

- OW2480 – 37" – Mullion Mount with Remote Power Supply
- OW2482 – 37" – Junction Box Mount with Integral Power Supply
- OW2484 – 72" – Mullion Mount with Remote Power Supply
- OW2486 – 72" – Junction Box Mount with Integral Power Supply

See Visalighting.com/products/Passage for more information

SUGGESTED VARIATIONS

- Custom colors

FINISHES

Specify color code when ordering. For accurate color matching, individual paint and finish samples are available upon request.
For more information about our finishes visit visalighting.com/finishes

Powder Coat Paint Finishes (Standard)

AGGY Agate Grey	**ALGN** Alpine Green	**BJBG** Baja Beige	**BMAT** Bronze Matte	**BRNZ** Bronze	**BSIL** Blade Silver	**CVBL** Cove Blue
DEOR Deoro Gold	**GLWT** Glacier White	**GSIL** Graphite Siver	**HRGR** Harbor Grey	**JTBK** Jet Black	**OCBL** Ocean Blue	**SHGR** Shoreline Grey
SBGN Sagebrush Green	**SLGR** Slate Grey	**SSTP** Sierra Taupe	**TRCN** Terracotta Canyon	**TRWT** Traffic White	**VBLK** Velvet Black	**VNRD** Vineyard Red

This document contains information which is the property of Visa Lighting, and may not, in whole or in part, be duplicated, disclosed, or used for design or manufacturing purposes without the prior written permission of Visa Lighting. ©Visa Lighting. Design Modification Rights Reserved.

EQUIPMENT

MANUFACTURER	Ligman Lighting
CATALOG NUMBER	ULEW-30011-14w-T2-W30-02-120/277v
TOTAL WATTS	14
VOLTAGE	120v-277v
MOUNTING	Wall
WEIGHT	12lbs
DIMENSIONS	8.11" x 4.97" x 8.03"
FINISH	BLACK
RATING	IP65
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000k
CRI	
LUMEN OUTPUT	1660
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Wall mount fixed sconce with one (1) LED lighting source, 1660 delivered lumens, 3000k color engine and integral driver. Sconce should operate on 120v-277v voltage and be supplied with a 0-10v control option and include a minimum 10-year warranty. Sconce to have black finish. Sconce to be rated for IP65 or equivalent. Sconce should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

ULEW-30011

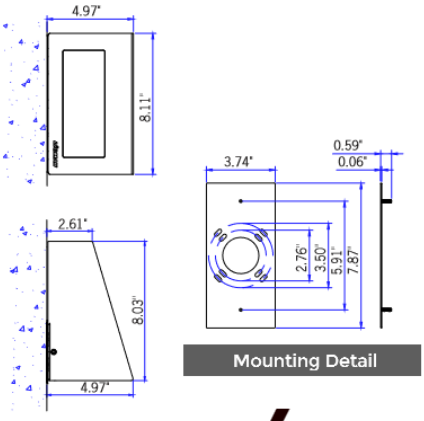
B95
ULEW-30011-14w-T2-W30-02-120/277v

Leeds 2 Medium Surface Wedge Downlight

microVos TECHNOLOGY

LIGMAN LIGHTING USA

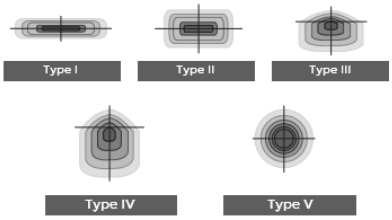
14w LED 1660 Lumens
IP65 • Suitable For Wet Locations
IK07 • Impact Resistant
Weight 12 lbs



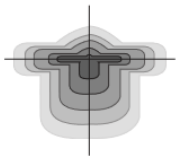
Mounting Detail

microVos TECHNOLOGY

Ligman's micro Variable Optical System provides the ability to interchange, mix & rotate optics to provide specific light distributions for optimized spacing and uniformity.



The variable optic system allows for the designer to create hybrid distributions for precise lighting requirements.



HYBRID
TYPE I & TYPE IV

Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
B0 - U0 - G0 [T2, T3/W30, T4, ME/W40]
B1 - U0 - G0 [T3/W40, W/W30, ME/W30, EW]
B2 - U0 - G0 [W/W40]
B1 - U0 - G1 [T1]

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200 Deg C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
- Resistance to salt-acid room, accelerated aging
- Boiling water, lime and condensed water resistant
- Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
- Super durable (UV resistant)
- TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light. LED CRI > 80

Lumen • Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Clean, beautiful, surface wall fixtures with class leading performance. Minimalist form, yet the most powerful and flexible lighting tool of its type, offering packages up to 2,400 lumens and microVos technology.

A range of small, square and rectangular, ADA compliant wall mounted luminaires with options of upward or downward light distributions. Ideally suited to illuminate the wall and surfaces in front of wall and for light accents on vertical surfaces using high efficiency LED's. The Leeds is suitable for indoor and outdoor applications and provides a clean, visually appealing solution for small, unobtrusive wall mounted luminaires.

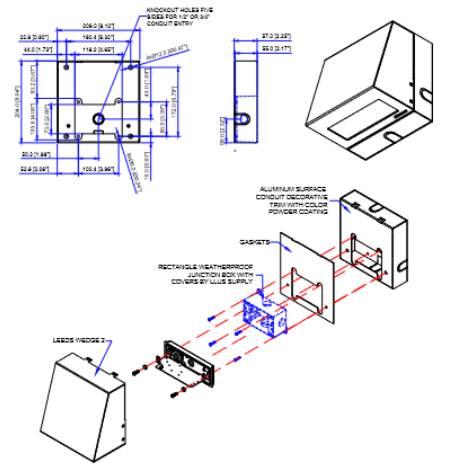
This luminaire is available in 3 different sizes and in combinations of down, up or up/down light distributions.

This fixture utilizes microVos technology, meaning the ability to do Type I,II,III,IV & V distributions as well as hybrid distributions to suit the designer's requirements.

Using the microVos optics allows for very wide spacing to mounting height ratios, while still providing perfect uniformity and code compliant light levels.

To meet International Dark Sky criteria, 3000k or warmer LEDs must be selected and luminaire fix mounted (+/- 15˚ allowable to permit leveling).

Additional Options (Consult Factory For Pricing)



SCBT
Surface Conduit Box Trim

NOTE: This trim covers a shallow single gang, surface mount junction box [Provided by contractor] Example: Hubbell: - 5322-0 - 1-Gang Weatherproof Box, Five 1/2" in. Threaded Outlets - or - 5322-0 - 1-Gang Weatherproof Box, Five 3/4 in. Threaded Outlets

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

ULEW-30011

Leeds 2 Medium Surface Wedge Downlight

microVos TECHNOLOGY

LIGMAN LIGHTING USA

PROJECT		DATE	
QUANTITY		TYPE	
NOTE			

ORDERING EXAMPLE || ULEW - 30011 - 14w - T2 - W30 - 02 - 120/277v - Options

ULEW-30011	14w	T4	3000K	01	120/277V
	LAMP	BEAM	LED COLOR	FINISH COLOR	VOLTAGE

LAMP
- 14w LED 1660 Lumens

BEAM
- T1 - Type I Distribution
- T2 - Type II Distribution
- T3 - Type III Distribution
- T4 - Type IV Distribution
- M - Medium 30˚
- W - Wide 56˚
- EW - Extra Wide 99˚x102˚

LED COLOR
- W27 - 2700K
- W30 - 3000K
- W35 - 3500K
- W40 - 4000K

FINISH COLOR
- 01 - BLACK RAL 9011
- 02 - DARK GREY RAL 7043
- 03 - WHITE RAL 9003
- 04 - METALLIC SILVER RAL 9006
- 05 - MATTE SILVER RAL 9006
- 06 - LIGMAN BRONZE
- 07 - CUSTOM RAL

VOLTAGE
- 120/277v
- Other - Specify

INSPIRED BY NATURE FINISHES
- SW01 - OAK FINISH
- SW02 - WALNUT FINISH
- SW03- PINE FINISH
- DF - DOUGLAS FIR FINISH
- CW - CHERRY WOOD FINISH
- NW - NATIONAL WALNUT FINISH
- SU01 - CONCRETE FINISH
- SU02 - SOFTSCAPE FINISH
- SU03 - STONE FINISH
- SU04 - CORTEN FINISH

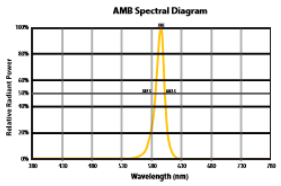
THERE IS AN ADDITIONAL COST FOR THESE FINISHES

ADDITIONAL OPTIONS

- BPC - Button Photocell
- SCBT - Surface Conduit Box Trim
- F - Frosted Lens
- AMB - Turtle Friendly Amber LED
- DIM - 0-10v Dimming
- NAT - Natatorium Rated

BPC
Button Photocell

CITY OF FLAGSTAFF & TURTLE FRIENDLY COMPLIANT



Narrow-Spectrum Amber LEDs
Peak wavelength between 585 & 595 nanometers and a full width of 50% power no greater than 15 nanometers.

More Custom Finishes Available Upon Request

Consult factory for pricing and lead times

Example: Inspired by Nature Finish

Intertek

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

Leeds Product Family

Leeds 1 - Up/Down

- ULEE-30031-2x5.5w-2x570lm

Leeds 2 - Down

- ULEE-30001-5.5w-570lm

Leeds 3 - Up/Down

- ULEE-30041-2x14w-2x1660lm

Leeds 4 - Down

- ULEE-30011-14w-1660lm

Leeds 5 - Up/Down

- ULD-30051-2x20w-2x2422lm

Leeds 6 - Down

- ULEE-30021-20w-2422lm

Leeds Wedge Product Family

Leeds Wedge 1

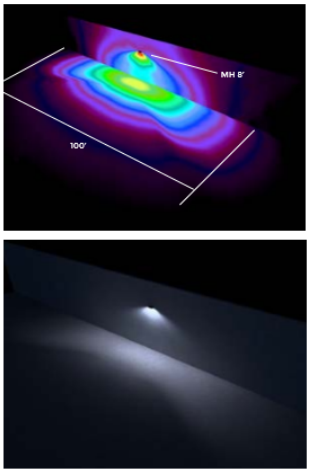
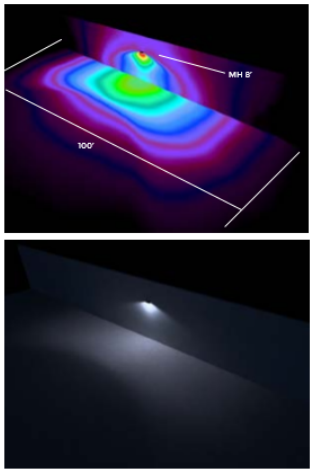
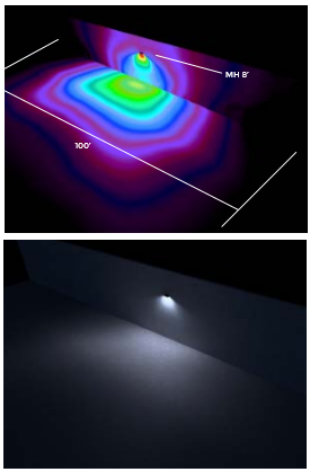
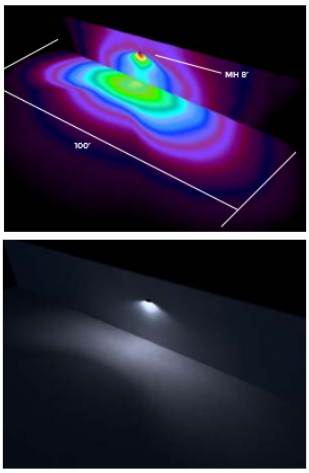
- ULEW-30001-5.5w-570lm

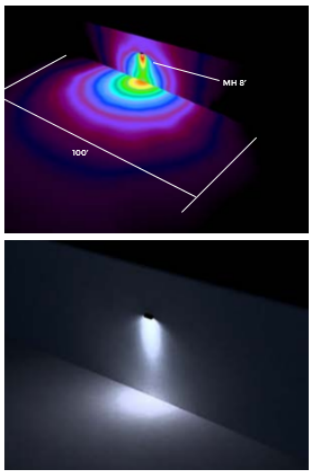
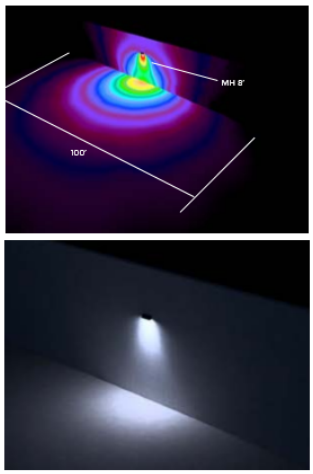
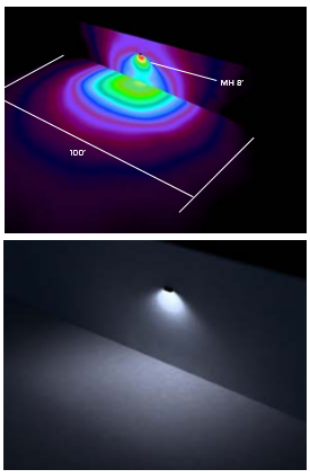
Leeds Wedge 2

- ULEW-30011-14w-1660lm

Leeds Wedge 3

- ULEW-30021-20w-2422lm

Type II Distribution	Type III Distribution	Type IV Distribution	Type ME Distribution
			

Medium Beam - 30˚	Wide Beam - 56˚	Extra Wide Beam - 99˚ x 102˚
		

EQUIPMENT

MANUFACTURER	Allied Maker
CATALOG NUMBER	CEI-147
TOTAL WATTS	18
VOLTAGE	120
MOUNTING	Pendant
WEIGHT	14.25
DIMENSIONS	
FINISH	Brass and Hardwood
RATING	IP
LISTING	UL

SOURCE

MANUFACTURER	Emery Allen
CATALOG NUMBER	EA-G8-4.5-001-279F-D
QUANTITY	4
CCT	
CRI	
LUMEN OUTPUT	
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Decorative Pendant mount fixed shade lightfour (4) , 360° optic and integral driver. Shade Light should operate on 120 voltage and be supplied with a line voltage dimmer control option. Shade light to have brass and hardwood finish. Shade Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	

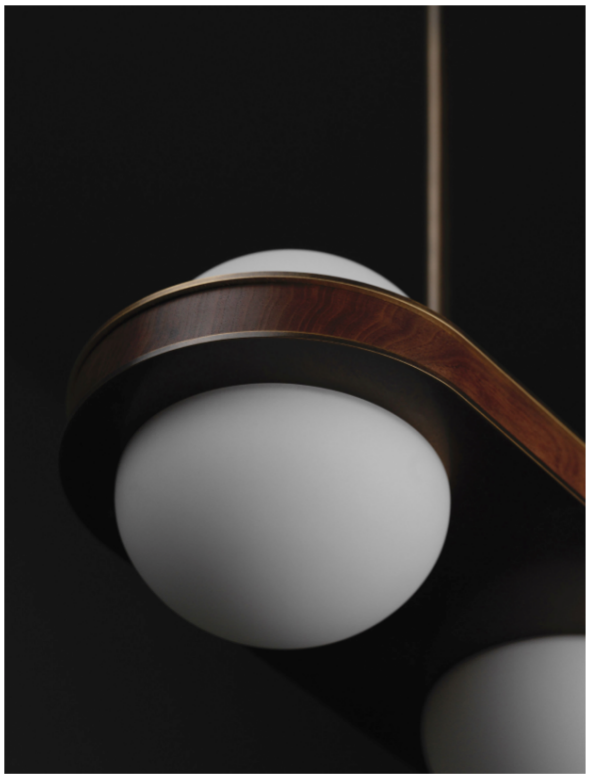
NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Array 2 Pendant

ALLIED MAKER

CEI-147



SALES@ALLIEDMAKER.COM (212) 334-7333 81 FRANKLIN ST. NYC HANDCRAFTED IN USA

Array 2 Pendant

ALLIED MAKER

CEI-147

DESCRIPTION

The Array 2 Pendant delivers elegantly diffused light through a pair of hand-blown glass hemispheres. The Glass rests on cantilevered joinery of Brass and Hardwood that gives a rich material interest to the fixture's simple and clean lines.

MATERIALS

Brass, Glass, Wood

METAL FINISHES

Available in All Standard Metal Finishes

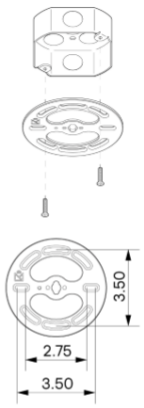
GLASS FINISHES

Matte White

WOOD FINISHES

Available in All Standard Wood Finishes

MOUNTING HARDWARE DIAGRAM



MOUNTING

Universal

WEIGHT

14.25 lb

LAMPING

G8 Bi-Pin Base. Type T Lamps

BULB INCLUDED (120V USA)

Emery Allen 4.5W G8 Bulb

BULB INCLUDED (240V EU)

Emery Allen 4.5W G8 240V Bulb

LAMP QUANTITY

4

BRIGHTNESS

1800 Lumens

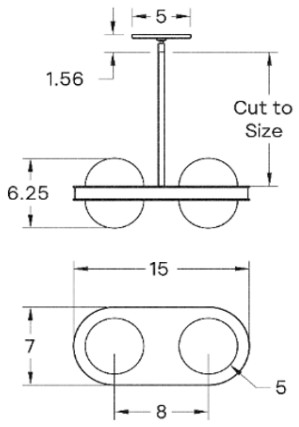
MAX WATTAGE

6W

DIMMING

LED+

DIMENSIONAL DRAWING



CERTIFICATIONS

CE, Damp Locations, UL and cUL Certified

CERTIFIED E469387

SALES@ALLIEDMAKER.COM (212) 334-7333 81 FRANKLIN ST. NYC HANDCRAFTED IN USA

EmeryAllen

G8 4.5W

SPECIFICATIONS & TECHNICAL DATA

The 120V EmeryAllen G8 retrofit lamp is an energy efficient alternative to incandescent G8 base lamps. It offers similar light output to a 120V, 50W incandescent (450lm) and is suitable for use in most 120V G8 fixtures.

Base Type	G8
Material	Ceramic + PC
Input Voltage	100-130V AC
Wattage	4.5
CRI	90+
Brightness	450 lumens
Lumens/Watt	100
Color Temperature	2700K, 3000K +
R9	52
R13	96
Halogen Equivalent	50W
Beam Angle	360 degrees
Life	25,000 hours
Warranty	Limited Lifetime*

Available Models:

- EA-G8-4.5W-001-279F-D (2700K)
- EA-G8-4.5W-001-309F-D (3000K)

Dimming:

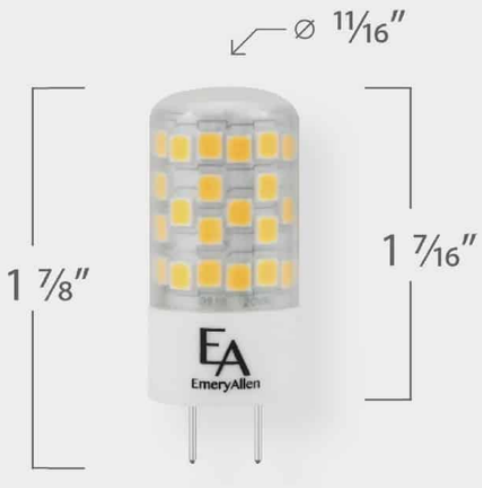
Dimmable with most incandescent and LED dimmers.

US PAT: US D850,663 ; US 10,605,412

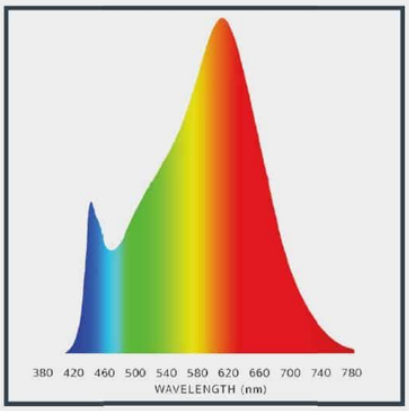
LUTRON. DIMMER COMPATIBLE

120V SERIES

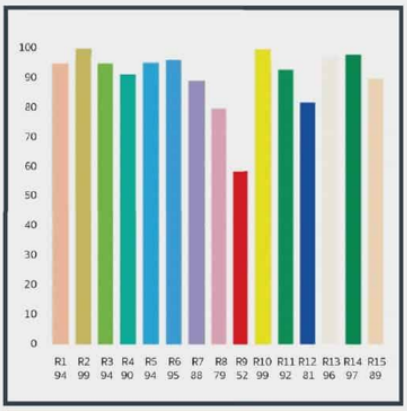
© 2020 EmeryAllen, LLC. All Rights Reserved, Patent Pending
*Please review complete warranty information at www.EmeryAllen.com
*Images/Information subject to change. Images not to scale.



SPECTRAL DISTRIBUTION



CRI VALUES R1-R15



EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	IVO4CYL PC D 25LM 30K 80CRI 15D DARK MVOLT EZT L9 JBX CAN C120 P AR LS DBL
TOTAL WATTS	26.5
VOLTAGE	120-277
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5 1/2" x 5 1/2" x 9"
FINISH	Matte Black
RATING	IP
LISTING	CSA

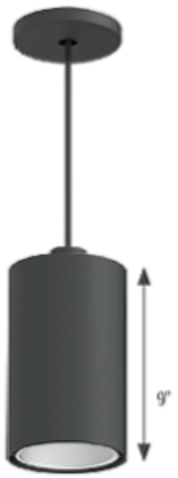
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Pendant mount fixed cylinder with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 15° optic and integral driver. Cylinder should operate on 120 -277 voltage and be supplied with a 0-10v control option down to <1% and include a minimum 5-year warranty with a 55,000 hour anticipated life. Cylinder to have matte black finish. Cylinder should be CSA listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Visual Terrain® www.visualterrain.net		PROJECT: Bentonville Ballroom CLIENT: Live Nation SUBMISSION: 100% Detail Design DOCUMENT #:	**EQUIPMENT TYPE**
DATE: 10/23/2026	REVISION #		C61
PAGE 86 OF 505	0	Equipment Page 2 of 2	

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	IVO4CYL PC D 25LM 30K 80CRI 20D DARK MVOLT EZT L9 JBX CAN C120 P AR LS DBL
TOTAL WATTS	26.5
VOLTAGE	120-277
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5 1/2" x 5 1/2" x 9"
FINISH	Matte Black
RATING	IP
LISTING	CSA

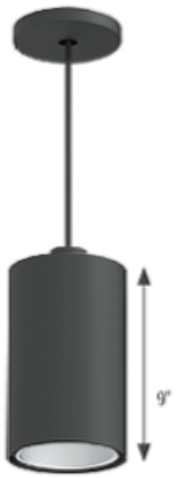
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Pendant mount fixed cylinder with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 20° optic and integral driver. Cylinder should operate on 120 -277 voltage and be supplied with a 0-10v control option down to <1% and include a minimum 5-year warranty with a 55,000 hour anticipated life. Cylinder to have matte black finish. Cylinder should be CSA listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

EQUIPMENT

MANUFACTURER	Acuity (Gotham)
CATALOG NUMBER	IVO4CYL PC D 25LM 30k 80CRI 25D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL
TOTAL WATTS	26.8
VOLTAGE	Mvolt
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5.5" x 5.5" x 9"
FINISH	Black
RATING	IP
LISTING	CSA

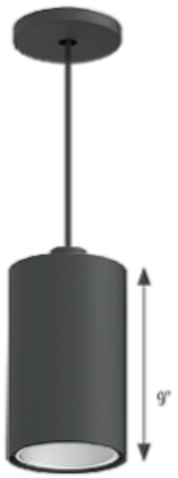
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Pendant mount fixed cylinder with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 25° optic and integral driver. Cylinder should operate on Mvolt voltage and be supplied with a 0-10v control option down to .01 and include a minimum 5-year warranty with a 55,000 hour anticipated life. Cylinder to have black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

EQUIPMENT

MANUFACTURER	Acuity (Gotham)
CATALOG NUMBER	IVO4CYL PC D 25LM 30k 80CRI 30D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL
TOTAL WATTS	26.8
VOLTAGE	Mvolt
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5.5" x 5.5" x 9"
FINISH	Black
RATING	IP
LISTING	CSA

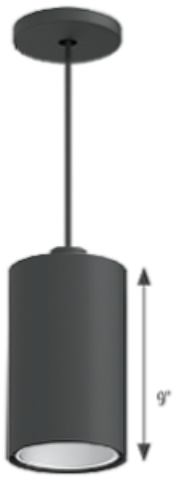
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Pendant mount fixed cylinder with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 30° optic and integral driver. Cylinder should operate on Mvolt voltage and be supplied with a 0-10v control option down to .01 and include a minimum 5-year warranty with a 55,000 hour anticipated life. Cylinder to have black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

EQUIPMENT

MANUFACTURER	Acuity (Gotham)
CATALOG NUMBER	IVO4CYL PC D 25LM 30k 80CRI 35D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL
TOTAL WATTS	26.8
VOLTAGE	Mvolt
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5.5" x 5.5" x 9"
FINISH	Black
RATING	IP
LISTING	CSA

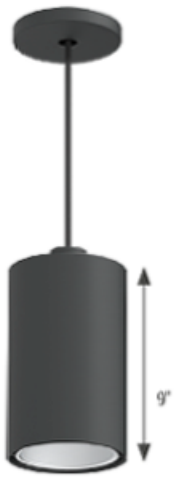
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Pendant mount fixed cylinder with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 35° optic and integral driver. Cylinder should operate on Mvolt voltage and be supplied with a 0-10v control option down to .01 and include a minimum 5-year warranty with a 55,000 hour anticipated life. Cylinder to have black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

gotham | I V O™

Luminaire Type: C65

Catalog Number: IVO4CYL PC D 25LM 30k 80CRI 35D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL

IVO™ 4" Round Cylinders
Pendant Mount

MOUNTING STYLES AND TRIM COLORS

Canopy with Recessed J-box (JBX)

Canopy with Surface J-box (JBX)

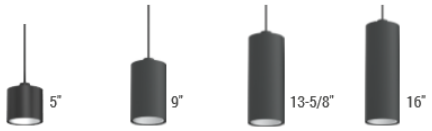
Conduit Cover Canopy with Surface J-box (JBXCC)

Surface Gear Box with Recessed J-Box (SGB)

Surface Gear Box with Surface J-Box (SGB)

Conduit Cover Surface Gear Box with Surface J-Box (SGBCC)

Cylinder Lengths



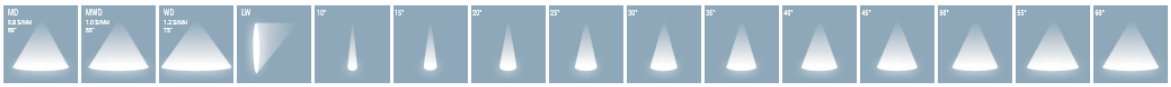
Shallow | Standard | Long | Extra Long

QUICK SPECIFICATIONS

Feature Set

- Perfect Color™ consistency within 1/2-step MacAdam Ellipse
- 45° visual cut-off angle to source (65° for 5" tall)
- Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare
- Available with 10%, 1%, or 0.1% dim to dark
- Rigid Stems are field cuttable with no threading required
- Patented Power Cord features integrated aircraft cable, providing discrete aesthetics with field-cuttable convenience
- 90% lumen maintenance at 55,000 hours
- Clean beams with soft transitions
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture
- Field changeable optics available every 5°
- Wet Location optional, covered ceiling

Distribution / Beam Angles



Superior Perfomance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	493	735	991	1486	1968	2447	2732	3313	3796	4236
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	96	100	101	99	96	91	92	96	91	94

*Based on Downlight performance: 3500K 80CRI MWD P AR LSS, for L9, L14, and L16. See Photometry section for Wall Wash performance. See IES files available online for L5 performanc

PRODUCT FAMILY

IVO 4" Round Product Family

Downlight | Lensed WW | Surface Cylinder | Pendant Cylinder | Wall Cylinder | Wall Adjustable Cylinder

NOM RoHS COMPLIANT WET LOCATION

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

gotham | IVO™

IVO™ 4" Round Cylinder Pendant Mount

Luminaire Type: **C65**

Catalog Number: **IVO4CYL PC D 25LM 30k 80CRI 35D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL**

EXAMPLE: IVO4CYL PC D 15LM 35K 80CRI MD MIN1 MVOLT ZT L5 JBX CAN C120 P AR LD DWH
EXAMPLE: IVO4CYL PC WW 20LM 35K 80CRI MIN1 MVOLT EZT L5 JBX CAN45 S10 LW BR LSS DBL

ORDERING INFORMATION

Series	Mounting Option	Function	Lumen Packages	Kelvin Temperature	Color Rendering Index	Distribution[3]
IVO4CYL IVO 4" Round Cylinder	PC Pendant Mount Cylinder	D Downlight WW Wall Wash	05LM[1] 500 Lumens 07LM 700 Lumens 10LM 1000 Lumens 15LM 1500 Lumens 20LM 2000 Lumens 25LM 2500 Lumens 30LM 3000 Lumens 35LM 3500 Lumens 40LM 4000 Lumens 45LM 4500 Lumens	27K 2700K 30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80+ CRI 90CRI[2] 90+ CRI, R9 50+ 95CRI[2] 95+ CRI, R9 80+	Narrow / Flood[4] 10D 10° 30D 30° 50D 50° 15D 15° 35D 35° 55D 55° 20D 20° 40D 40° 60D 60° 25D 25° 45D 45° General Illumination / Batwing MD Medium Batwing (0.8 s/mh, 60°) MWD Medium Batwing Wide (1.0 s/mh, 65°) WD Wide Batwing (1.2 s/mh, 75°)

Dimming Level	Voltage	Control Input[6]	Cylinder Length	Mounting Style
MIN10 Min 10% Dim Level MIN1 Min 1% Dim Level DARK Min 0.1% Dim Level, Dim-to-Dark	MVOLT Multi-Volt Input, 120V-277V 120 120V Input 277 277V Input 347[5] 347V Input	ZT[7] Generic 0-10V ELV[8] Phase Dimming (Forward/Reverse) (120V only) EZT EldoLED 0-10V DALI[9] DALI-2 DMX[9,10] DMX NLIGHT[11] Wired controls by nLight NLTAIR2[11] Wireless controls by nLight NLIGHTER[11] Wired controls by nLight with UL924 listed emergency operation NLTAIREM2[11] Wireless controls by nLight with UL924 listed emergency operation	L5[12] Shallow 5" Cylinder L9 Standard 9" Cylinder L14 Long 13-5/8" Cylinder L16 Extra Long 16" Cylinder	JBX Integral driver, Recessed or Surface J-box JBXCC Integral driver, Surface J-box with conduit covers SGB[13] Surface Gear Box, Recessed or Surface J-Box SGBCC[13] Surface Gear Box, Surface J-box with conduit covers

Canopy Cover	Pendant Length / Type	Fusing	Emergency Pack[16]	Wet/IP Listing
CAN Canopy, 5° hang straight swivel CAN45[14] Canopy, 45° hang straight swivel	S2 2ft x ø1/2" stem S4 4ft x ø1/2" stem S6 6ft x ø1/2" stem S8 8ft x ø1/2" stem S10 10ft x ø1/2" stem S12 12ft x ø1/2" stem S16 16ft x ø1/2" stem S20 20ft x ø1/2" stem C120[15] 10ft x ø5/16" cord C180[15] 15ft x ø5/16" cord C240[15] 20ft x ø5/16" cord	(blank) No Options SF Single Fuse, specify 120V or 277V	(blank) No Emergency Pack E7W[17] Emergency battery pack, Constant Power, Title 20 compliant, user selectable Self-Diagnostics, AC Activate with Integral Test Switch. E7WR 7W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) E10WR 10W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) E15WR 15W Emergency battery pack, Constant Power, Title 20 Compliant with Remote Test Switch (Sidecar)	(blank) Damp Location WL[18] Wet Location

Trim Style	Trim Color	Baffle Color	Trim Lens	Trim Finish[20]	Cylinder Color	
P[4] Parabolic Trim LW[19] Lensed Wall Wash BEV[20] Bevel Trim	AR Clear Anodized BR Black Anodized GR Gold Anodized PR Pewter Andozied WTR Wheat Anodized WR[20] White Paint WRAMF[20] White with Anti-Microbial Paint WMR[20] Soft White Paint BZR[20] Dark Bronze Paint TRALTBD[21] RAL Paint TCPCTBD Custom Paint	(blank) non-Bevel ARS Clear Anodized Semi-Specular WMRS Soft White BRS Black Semi-Specular BRD Black Diffuse	(blank) no lens SLG Solite Lens CLR Clear Lens	LSS Semi Specular LS Specular LD Matte Diffuse	DWH Gloss White DBL Matte Black DNA Gloss Natural Aluminum DWHAMF Gloss White Anti-Microbial DMB Matte Medium Bronze DDB Gloss Dark Bronze DSS Gloss Sandstone DGC Gloss Charcoal Grey DTG Gloss Tennis Green DBR Gloss Bright Red DSB Gloss Steel Blue	DDBT Textured Dark Bronze DBLB Textured Black DWHG Textured White DBNH Textured Bronze DNAT Textured Natural Aluminum DSST Textured Sandstone DSPD Textured Dark Grey DSPE Textured Green DSPH Textured Light Red RALTBD[21] RAL Paint CPC Custom Paint

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

ORDERING NOTES

1. 05LM only available with L5 Cylinder Length and ZT or ELV. 05LM not available with E7W.
2. 90CRI not available with 50K Kelvin Temperature. 95CRI not available with 35K, 40K or 50K Kelvin Temperature.
3. Not available with WW style Function.
4. Not available with L5 Cylinder Length.
5. 347 only available with ZT Control Input. Min10LM-Max 45LM. Not available with nLight, Emergency or SF Options. Not available with L5 Cylinder Length.
6. Refer to Tech-240 for compatible dimmers.
7. ZT not available with DARK.
8. ELV only available with MIN1 and 120 volt.
9. DALI and DMX only available with DARK.
10. DMX not available with L5 Cylinder Length. Only available with SGB or SGBCC Mounting.
11. nLight controls are provided with each fixture and can be remote mounted or mounted to the junction box. Wired NLIGHT and NLIGHTER controls include nPS 80 EZ dimming pack. Wireless NLTAIR2 and NLTAIREM2 controls include rPP20 power pack. Includes EZT driver. See Tables of Use on page 10.
12. L5 available up to 30LM max. Not available with E7W or 347.
13. Only available with DMX Control Input option.
14. Not available with SGB or SGBCC.
15. Power Mounting Cords are field cuttable. Not available with WW style Function. Color is determined by Architectural Color: White for DWHG, DWH, DWHAMF; Black for DBL, DBLB; Gray for all other color options.
16. Not available with 05LM, 25LM or 30LM with EZT or DALI control input for L5 Cylinder Length. Not available with 05LM with EZT or DALI Control Input for L9, L14 or L16 Cylinder Lengths.
17. E7W only available with ZT or ELV. Not available with 347, C120, C180, or C240. Available up to 20LM max for L9. Available up to 35LM max for L14 L16. E7W with WL available up to 15LM max.
18. WL only available with JBX. Not available with DMX or Emergency options. Min 05LM-30LM max for ZT or ELV in L5 Cylinder Lengths. Min 07LM-Max 20LM for EZT or DALI in L5 Cylinder Lengths. 30LM max for ZT or ELV in L9, L14 or L16 Cylinder Lengths. 07LM-30LM max for EZT or DALI in L9, L14 or L16 Cylinder Lengths.
19. LW not available with D style Function.
20. Optical finishes are not available with WR, WRAMF WMR and BZR trim colors.
21. Replace with applicable RAL number and finish when ready to order. See RAL BROCHURE for available color options.

ACCESSORIES – order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
GOTHAM IVO REFLECTOR COLOR KIT	Trim colors & finishes sample kit for standard IVO anodized and painted trim color options.
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting
CYLSTBL KIT	Stabilization Kit for securing pendant stem fixtures
IVO40PTC D MD	Field Replaceable 4" Downlight Optic, Medium Batwing Distribution, 0.8 s/mh, for L9-L16 Cylinder Lengths only
IVO40PTC D MWD	Field Replaceable 4" Downlight Optic, Medium Wide Batwing Distribution, 1.0 s/mh, for L9-L16 Cylinder Lengths only
NO40PTC D WD	Field Replaceable 4" Downlight Optic, Wide Batwing Distribution, 1.2 s/mh, for L9-L16 Cylinder Lengths only
IVO40PTC D 10D	Field Replaceable 4" Downlight Optic, 10°, for L9-L16 Cylinder Lengths only
IVO40PTC D 15D	Field Replaceable 4" Downlight Optic, 15°, for L9-L16 Cylinder Lengths only
IVO40PTC D 20D	Field Replaceable 4" Downlight Optic, 20°, for L9-L16 Cylinder Lengths only
IVO40PTC D 25D	Field Replaceable 4" Downlight Optic, 25°, for L9-L16 Cylinder Lengths only
IVO40PTC D 30D	Field Replaceable 4" Downlight Optic, 30°, for L9-L16 Cylinder Lengths only
IVO40PTC D 35D	Field Replaceable 4" Downlight Optic, 35°, for L9-L16 Cylinder Lengths only
IVO40PTC D 40D	Field Replaceable 4" Downlight Optic, 40°, for L9-L16 Cylinder Lengths only
IVO40PTC D 45D	Field Replaceable 4" Downlight Optic, 45°, for L9-L16 Cylinder Lengths only
IVO40PTC D 50D	Field Replaceable 4" Downlight Optic, 50°, for L9-L16 Cylinder Lengths only
IVO40PTC D 55D	Field Replaceable 4" Downlight Optic, 55°, for L9-L16 Cylinder Lengths only
IVO40PTC D 60D	Field Replaceable 4" Downlight Optic, 60°, for L9-L16 Cylinder Lengths only
IVO4SOPTIC D MD U	Field Replaceable Optic, Medium Distribution, for L5 Cylinder Length only
IVO4SOPTC D MWD U	Field Replaceable Optic, Medium Wide Distribution, for L5 Cylinder Length only
IVOSOPTC D WD U	Field Replaceable Optics, Wide Distribution, for L5 Cylinder Length only

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

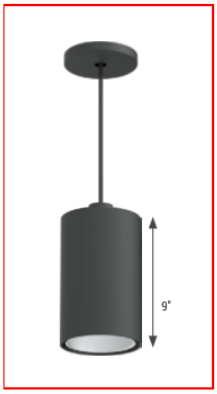
LENGTH AND TRIM OPTIONS

Cylinder Length

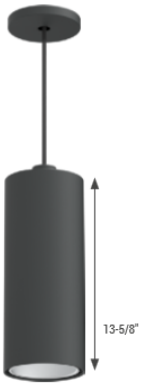
- Dimensions in inches [centimeters]
- L5 Cylinder has a 65° visual cut-off angle and trims and optics that are not interchangeable with the other Cylinder lengths

L5 - Shallow

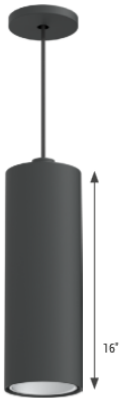
L9 - Standard



L14 - Long



L16 - Extra Long

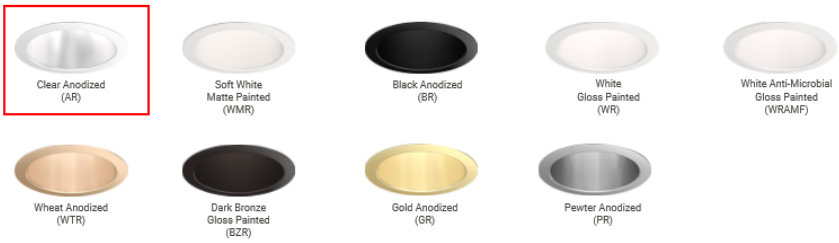


Trim Style

Optical Finish

Clear Anodized shown.

Trim Color



Parabolic shown.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

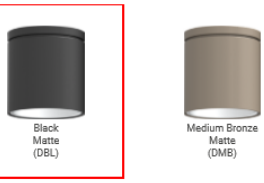
IVO™ 4" Round Cylinder Pendant Mount

ARCHITECTURAL COLORS

Textured Colors

Gloss Colors

Matte Colors



Note: These colors were carefully reproduced to give as true a depiction as possible of the finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please contact a Gotham representative for an Architectural Color Chip Kit (GCOLORS KIT), consisting of Powder-Coated and Plated Finishes.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

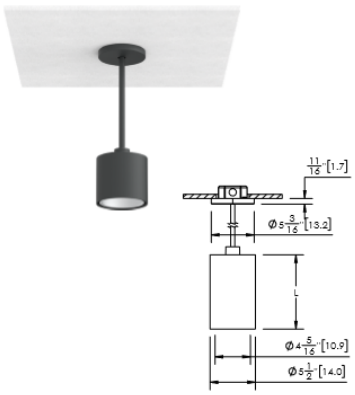
DIMENSIONAL DATA

Pendant Rigid Stem and Cord Mounting Options

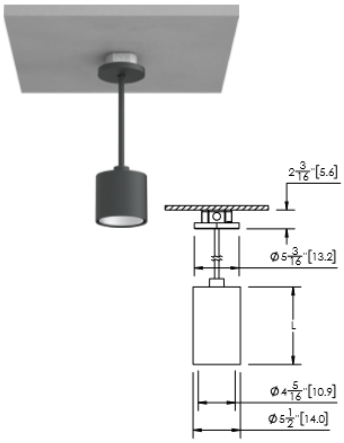
- Dimensions in inches [centimeters]
- Rigid Stems are Ø½" made of 2ft and 4ft field cuttable sections with no threading required, orderable from 2ft (S2) up to 20ft (S20).
- Powered Mounting Cords are Ø5/16" field cuttable down to 4" and include integrated Aircraft Cable (patent pending) for mechanical support without visible cable, orderable from 10ft (C120) up to 20ft (C240).
- J-boxes available by others (see Compatibility Table).

CYLINDER LENGTH (L)	DIMENSIONS INCHES (CM)
L5	5" (12.7)
L9	9" [22.9]
L14	13-5/8" [34.6]
L16	16" [40.6]

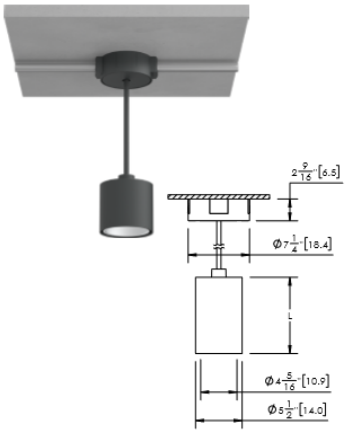
Canopy with Recessed J-box (JBX)



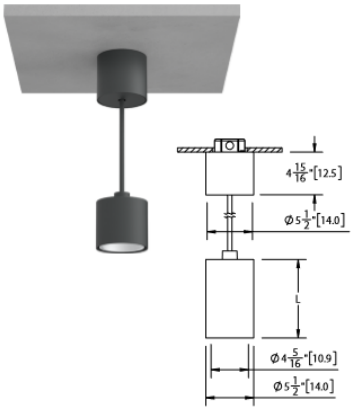
Canopy with Surface J-box (JBX)



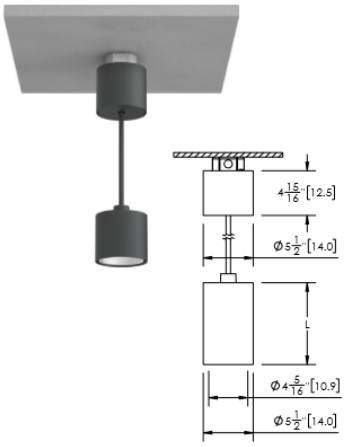
Conduit Cover Canopy with Surface J-box (JBXCC)



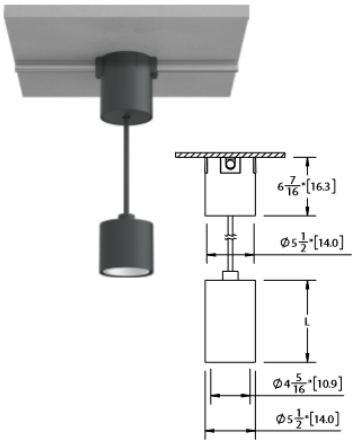
Surface Gear Box with Recessed J-box (SGB)



Surface Gear Box with Surface J-box (SGB)



Conduit Cover Surface Gear Box with Surface J-Box (SGBCC)



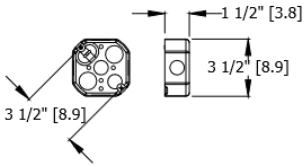
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

JUNCTION BOX AND CANOPY

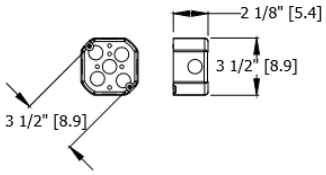
Junction Box and Canopy Details

- Dimensions in inches [centimeters]
- Options shown are available for Rigid Stem Mount or Powered Mounting Cord.
- J-boxes available by others.

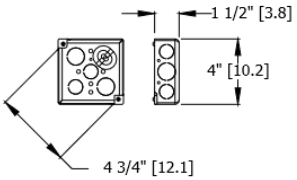
4" Octagonal j-box, 1-½" deep



4" Octagonal j-box, 2-1/8" deep

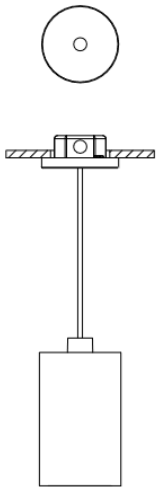


4" Square j-box, 1-½" deep

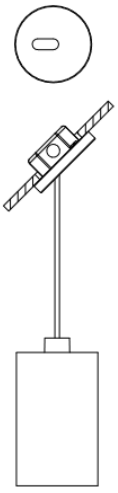


J-box Compatibility Matrix		Cylinder Configurations	
		JBX	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep	✓	✓
	4" Octagonal 4x4x2.125 deep	✓	×
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	×

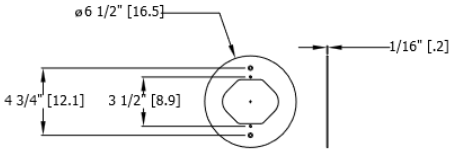
Standard Canopy (CAN) with 5° hang straight swivel



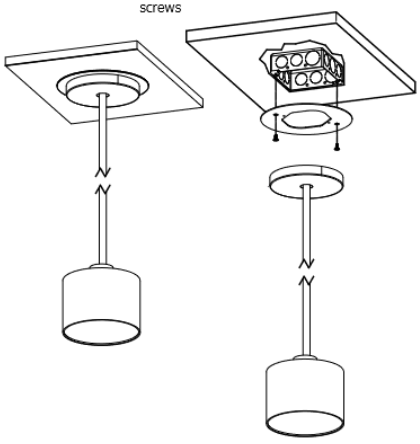
Canopy with Slot (CAN45) with 45° hang straight swivel



Cylinder Adaptor Plate (CYLJBOXADPT 4SQ20CT)



Includes 2 mounting screws



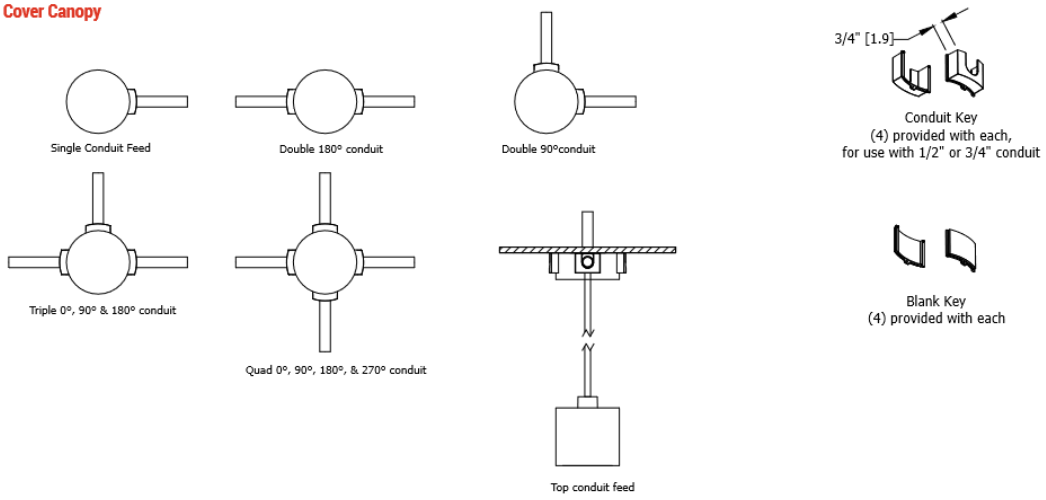
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

JUNCTION BOX AND CANOPY

Conduit Covers and Emergency Battery Sidecar

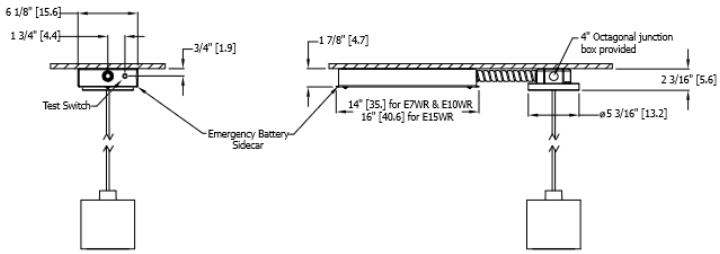
- Dimensions in inches [centimeters]
- Options shown are available for Rigid Stem Mount or Powered Mounting Cord.
- J-boxes available by others.

Conduit Cover Canopy

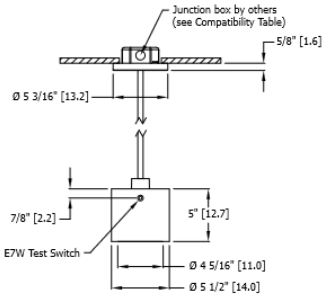


Emergency Battery Sidecar Enclosure

Emergency Battery Remote Test Switch (E7WR, E10WR, E15WR)



Emergency Battery Integral Test Switch (E7W)



How to Estimate Delivered Lumens in Emergency Mode
Delivered Lumens = 1.25 x P x LPW
P = Output Power/Wattage of Emergency Battery Driver (E7WR* = 7W, E10WR* = 10W, E15WR* = 15W)
LPW = Lumen per Watt rating of luminaire based on Ordering Code selections

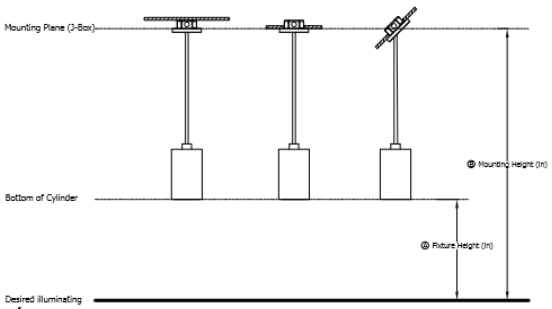
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

MOUNTING HEIGHT FORMULAS

Mounting Height Calculations for Field Cuttable Pendants

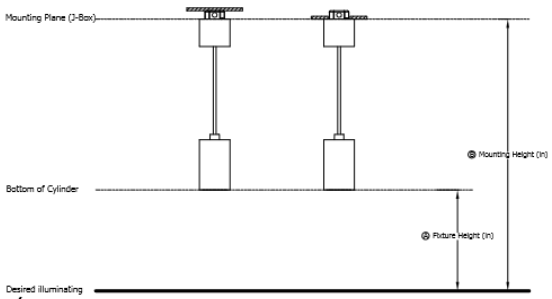
- Dimensions in inches [centimeters]
- J-boxes available by others.

Formulas for JBX/JBXCC



Rigid Stem Length=Ⓑ-Ⓐ- 5"
Mounting Cord Length=Ⓑ-Ⓐ

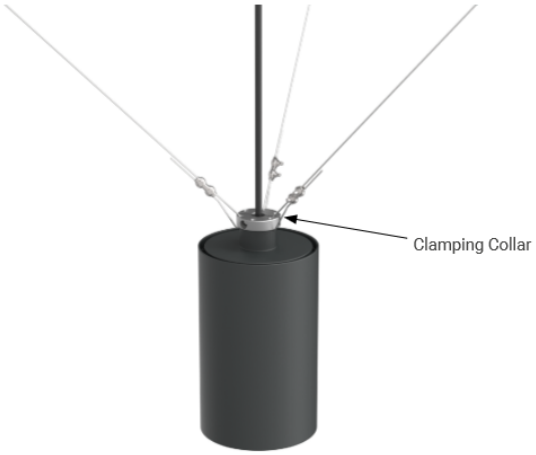
Formulas for SGB/SGBCC



Rigid Stem Length=Ⓑ-Ⓐ- 9"
Mounting Cord Length=Ⓑ-Ⓐ- 4"

Stabilization Kit

- Stabilization Kit (CYLSTBL KIT) offers additional support for applications where wind may be a factor and the Cylinder needs to be secured, for Rigid Stem Mount only.
- Clamping Collar consists of 2 half stem collars made of 304 grade stainless steel that clamp Rigid Stem using the socket head cap screw provided.
- 3 cables, ø1/16" x 20ft long and made of 304 grade stainless steel Aircraft Cable, support the Clamping Collar at one end and are anchored to the mounting surface at the other end (anchors by others).
- The Stabilization Kit is designed to withstand 90mph winds for 3 seconds per ASCE 7-10, MRI 50-year (fixture EPA is 0.2 sq ft).



GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

SPECIFICATIONS

Optical System
- Bounding Ray™ optical design delivers low brightness apertures for a comfortable lighting experience. Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare.
- 45° visual cut-off angle to source for L9, L14 and L16 lengths and 65° visual cut-off for L5 length per CIE 117-1995 Discomfort Glare in Interior Lighting (UGR FAQ)
- Top-Down Flash characteristics avoid flash on trim until source becomes visible.
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture. Available with 0.8, 1.0, and 1.2 spacing-to-mounting-height ratio (s/mh).
- Clean beams with soft transitions from narrow spot 10° up to wide flood 60° distributions and available every 5°.
- Optics are field changeable. However, L5 Cylinder Length optics aer not interchangeable with other Cylinder Length optics.

LED Light Engine
- Perfect Color™ consistency within 1/2-step MacAdam Ellipse using proprietary pick and place algorithm.
- 90% lumen maintenance at 55,000 hours.
- Available in 80, 90, or 95 CRI. 90 CRI has R9 greater than 50, 95 CRI has R9 greater than 80.

Trims
- Trims are field changeable via twist-lock (tool-free). However L5 Cylinder Length trims are not interchangeable with other Cylinder Lengths.
- Trims are available in 9 colors and 3 surface finishes (standard)
- Custom RAL and Paint colors available upon request.
- Trim lenses are made of Tempered Glass

Electrical
- 120, 277, 347, or Multi-Volt (MVOLT) 120-277 VAC input at 50/60 Hz.
- Power Factor > 85%.
- Input wires 18 AWG, 600V minimum, solid copper.

EMI/RFI
- EMI/RFI per FCC Title 47 CFR, Part 15, Class A rated standard.
- EMI/RFI per FCC Title 47 CFR, Part 15, Class B rated for Phase Dimming driver (ELV) except when used with Emergency Battery (E7WR, E10WR, E15WR) or at 15LM and above.

Controls (Optional)
- Luminaire can be equipped with interface for nLight wired, allowing it to communicate over an nLight network. nLight wired options ship with an nPS 80 EZ power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Couple with nLight-enabled sensors, power packs, or WallPods using CAT-5 cabling to create an nLight Control Zone. Link Control Zone to a Gateway directly or via a Bridge for remote status monitoring and control using SensorView software.
- Luminaire can be equipped with interface for nLight Air, allowing it to communicate over the wireless nLight control platform. nLight Air options ship with an rPP20 power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Can be paired to other luminaires and wall switches through CLAIRITY+, a mobile app, which allows individual fixture control.

Dimming
- Luminaire Is capable of continuous dimming without perceivable flicker (stroboscopic) as measured by flicker index (ASNI/IES RP-16-10).
- Available dimming ranges include: 100%-10% (MIN10), 100%-1% (MIN1), and 100%-0.1% (DARK) of rated lumen output.
- Available with smooth shut off function from minimum dimming level to 0%.
- EldoLED drivers (EZT, DALI) conform to IEEE P1789 standards.
- Drivers are inaudible in 24dB environment and stable even when input voltage conditions experience typical commercial environment fluctuations.

Emergency Battery (Optional)
- Luminaires equipped with battery pack (E7W, E7WR, E10WR, E15WR) comply with NFPA 101 (Life Safety Code) and deliver constant light output for a duration of 90 minutes minimum with AC power loss.
- Emergency batteries with Remote Test Switch (E7WR, E10WR, E15WR) are mounted to ceiling via remote enclosure (sidecar).
- Emergency battery is CEC T20 compliant.

Installation
- Rigid Stems are field cuttable with no threading required.
- Rigid Stem lengths consist of 2ft and 4ft sections.
- Powered Mounting Cords are field cuttable down to 4" and include integrated Aircraft Cable (patented) for mechanical support without visible cable.
- Luminaire can be installed to 4" Octagonal j-box (1-1/2" or 2-1/8" deep depending on ordering configuration).
- Luminaire can be installed to 4" Square j-box (1-1/2" deep) when used with Cylinder Adaptor Plate (CLYLJBOXADPT 4SQ20CT).
- Optional, field configurable Conduit Covers are available and match Cylinder finish and diameter.

Construction
- Heavy-gauge extruded Aluminum construction.
- Reflector design allows air flow across heatsink to improve thermal management.
- Light Engine and Driver are field replaceable and serviceable from below the ceiling.

Listings
- Fixtures are CSA certified to meet US and Canadian standards.
- All fixtured are manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" per UL.
- Damp Location standard.
- Wet Location available.

Photometrics
- All photometry is conducted by IESNA standard LM-79-08 in an accredited lab.
- LEDs are tested to LM-80 standards. Lumen maintenance is calculated via TM-21.

Warranty
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:
- Actual performance may differ as a result of end-user environment and application.
- All values are design or typical values, measured under laboratory conditions at 25 °C.
- The product images shown are for illustration purposes only and may not be an exact representation of the product.

© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

TABLES OF USE

Dimming Configurations

Dimming Level		Control Input	Dimming Level	Driver Dim Curve	Recommended Control Dim Curve
MIN10	+	ZT	100% to 10%	Linear	Linear/Logarithmic
	+	EZT	100% to 10%	Linear	Linear/Logarithmic
MIN1	+	ZT	100% to 1%	Linear	Linear/Logarithmic
	+	EZT	100% to 1%	Linear	Linear/Logarithmic
	+	ELV	100% to 1%*	n/a	n/a
DARK	+	EZT	100% to 0.1%	Logarithmic	Linear
	+	DMX	100% to 0.1%	Square	Linear
	+	DALI	100% to 0.1%	Logarithmic	Linear

* ELV Minimum Dimming level depends on dimmer and dimmer load

Night Configurations

Dimming Level		Control Input	Dimming Level	Control Provided	Driver Provided
MIN10	+	NLIGHT	100% to 10%	NPS 80 EZ	eldoLED ECOdrive
	+	NLIGHTER	100% to 10%	NPS 80 EZ ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 10%	RPP20	eldoLED ECOdrive
	+	NLTAIREM2	100% to 10%	RPP20 EM	eldoLED ECOdrive
MIN1	+	NLIGHT	100% to 1%	NPS 80 EZ	eldoLED ECOdrive
	+	NLIGHTER	100% to 1%	NPS 80 EZ ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 1%	RPP20	eldoLED ECOdrive
	+	NLTAIREM2	100% to 1%	RPP20 EM	eldoLED ECOdrive
DARK	+	NLIGHT	100% to 0.1%	NPS 80 EZ	eldoLED SOLOdrive
	+	NLIGHTER	100% to 0.1%	NPS 80 EZ ER	eldoLED SOLOdrive
	+	NLTAIR2	100% to 0.1%	RPP20	eldoLED SOLOdrive
	+	NLTAIREM2	100% to 0.1%	RPP20 EM	eldoLED SOLOdrive

IVO4CYL D L5		Drivers:	Title 24, JA8 ZT, ELV	Energy Star EZT, ZT, ELV, DALI
DOWNLIGHT	80CRI	2700K		✓[2]
		3000K		✓[2]
		3500K		✓[2]
		4000K		✓[2]
		5000K		✓[2]
	90CRI	2700K		✓[2,3]
		3000K		✓[2,3]
		3500K	✓[1]	✓[2,3]
		4000K	✓[1]	✓[2,3]
	95CRI	2700K	✓[1]	
		3000K	✓[1]	

Applicable for L5 length Downlight Cylinders only.
1 - E7WR, E10WR, and E15WR are not T24 complaint.
2 - E7WR is not Energy Star complaint.
3 - 90CRI with 05LM and ELV or ZT is not Energy Star complaint.

IVO4CYL WW L5		Drivers:	Title 24, JA8 ZT, ELV	Energy Star EZT, ZT, ELV, DALI
WALL WASH	80CRI	2700K		✓[1,2]
		3000K		✓[1,2]
		3500K		✓[1,2]
		4000K		✓[1,2]
		5000K		✓[1,2]
	90CRI	2700K		✓[1,2]
		3000K		✓[1,2]
		3500K		✓[1,2]
		4000K		✓[1,2]
	95CRI	2700K		
		3000K		

Applicable for L5 length Wall Wash Cylinders only.
1 - E7WR is not Energy Star complaint.
2 - 05LM and 07LM are not Energy Star complaint.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

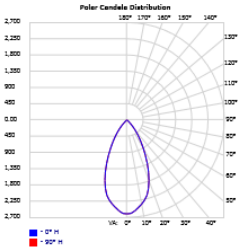
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

PHOTOMETRY

MD Medium Beam

IVO4CYL PC D 20LM 35K 80CRI MD L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 1920, LPW: 94, S/MH: ..8, Test No: 24-850-22P3302



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

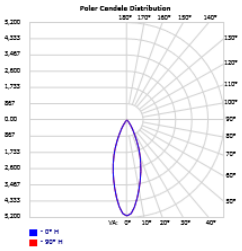
Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

35 Degree Beam

IVO4CYL PC D 20LM 35K 80CRI 35D L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 2044.6, LPW: 100, S/MH: .54, Test No: 24-850-34P1217



Candela Summary	
0°	5116
10°	3734
20°	2039
30°	675
40°	120
50°	14
60°	4
70°	2
80°	1
90°	0

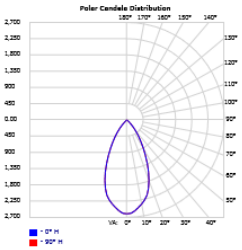
Zonal Lumen Summary		
Zone	Lumens	%
0-30	1778.1	87.0%
0-40	1992.7	97.5%
0-60	2040.2	99.8%
0-90	2044.6	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	79.94	4.8	4.8
10'	51.16	6	6
12'	35.53	7.2	7.2
14'	26.1	8.4	8.4
16'	19.99	9.6	9.6

50 Degree Beam

IVO4CYL PC D 20LM 35K 80CRI 50D L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 1920.1, LPW: 94, S/MH: .8, Test No: 24-850-22P3310



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

CRI/CCT Multiplier		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Trim Color and Finish Multiplier		
Trim Color	Trim Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

UGR (70% 50% 20% reflectance using a 4H x 8H room size)						
Lumen Package	Crosswise			Endwise		
	MD	MWD	WD	MD	MWD	WD
05LM	7.9	4.9	4.9	7.9	4.9	4.9
07LM	9.2	6.2	6.2	9.2	6.2	6.2
10LM	10.3	7.3	7.3	10.3	7.3	7.3
15LM	11.4	8.4	8.4	11.4	8.4	8.4
20LM	12.3	9.4	9.3	12.3	9.4	9.3
25LM	13	10.1	10.1	13	10.1	10.1
30LM	13.6	10.6	10.6	13.6	10.6	10.6

*UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.

**Calculated using an AR (Clear reflector) with LSS (Semi-Specular) finish

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

PHOTOMETRY

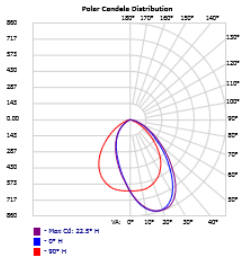
Superior Performance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	340	507	683	1025	1357	1687	1884	2285	2618	2921
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	66	69	69	69	66	63	63	66	63	64

*Based on Lensed Wall Wash performance: 3500K 80CRI MD P AR LSS, for L9, L14, and L16. See IES files available online for L5 performance.

LW Lensed Wall Wash

IVO4CYL PC WW 20LM 35K 80CRI L9/L14/L16 LW AR LSS **Wattage: 20.5, Lumens: 1357.4, LPW:66, S/MH: 1.5, Test No: 24-824-1P224**



Candela Summary	
0°	633
10°	800
20°	851
30°	759
40°	550
50°	346
60°	199
70°	101
80°	32
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	503.8	37.1%
0-40	804.4	59.3%
0-60	1238.8	91.3%
0-90	1357.4	100.0%

CRI/CCT Multiplier		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Trim Color and Finish Multiplier		
Trim Color	Trim Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

NLIGHT

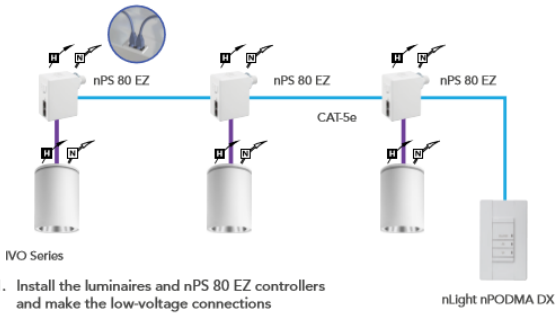
nLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Controls



1. Install the luminaires and nPS 80 EZ controllers and make the low-voltage connections
2. Install the nLight Wired wall switch
3. Connect the nLight devices using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Controls

1. Install the luminaires and rPP20 power/relay packs
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY™+ mobile app to pair the luminaires with the wall switch and if desired, customize the device settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Acuity (Gotham)
CATALOG NUMBER	IVO4CYL PC D 25LM 30k 80CRI 40D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL
TOTAL WATTS	26.8
VOLTAGE	Mvolt
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5.5" x 5.5" x 9"
FINISH	Black
RATING	IP
LISTING	CSA

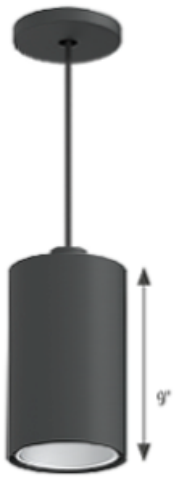
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Pendant mount fixed cylinder with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 40° optic and integral driver. Cylinder should operate on Mvolt voltage and be supplied with a 0-10v control option down to .01 and include a minimum 5-year warranty with a 55,000 hour anticipated life. Cylinder to have black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

gotham | I V O™

Luminaire Type: C66

Catalog Number: IVO4CYL PC D 25LM 30k 80CRI 40D DARK MVOLT EZT L9 JBX C120 P AR LSS DBL

IVO™ 4" Round Cylinders
Pendant Mount

MOUNTING STYLES AND TRIM COLORS

Canopy with Recessed J-box (JBX)

Canopy with Surface J-box (JBX)

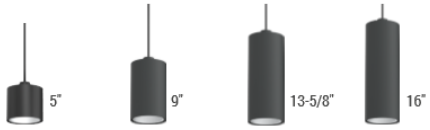
Conduit Cover Canopy with Surface J-box (JBXCC)

Surface Gear Box with Recessed J-Box (SGB)

Surface Gear Box with Surface J-Box (SGB)

Conduit Cover Surface Gear Box with Surface J-Box (SGBCC)

Cylinder Lengths



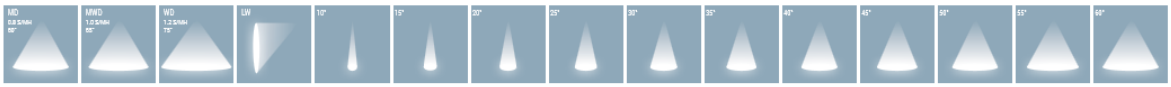
Shallow | Standard | Long | Extra Long

QUICK SPECIFICATIONS

Feature Set

- Perfect Color™ consistency within 1/2-step MacAdam Ellipse
- 45° visual cut-off angle to source (65° for 5" tall)
- Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare
- Available with 10%, 1%, or 0.1% dim to dark
- Rigid Stems are field cuttable with no threading required
- Patented Power Cord features integrated aircraft cable, providing discrete aesthetics with field-cuttable convenience
- 90% lumen maintenance at 55,000 hours
- Clean beams with soft transitions
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture
- Field changeable optics available every 5°
- Wet Location optional, covered ceiling

Distribution / Beam Angles



Superior Perfomance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	493	735	991	1486	1968	2447	2732	3313	3796	4236
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	96	100	101	99	96	91	92	96	91	94

*Based on Downlight performance: 3500K 80CRI MWD P AR LSS, for L9, L14, and L16. See Photometry section for Wall Wash performance. See IES files available online for L5 performanc

PRODUCT FAMILY

IVO 4" Round Product Family

Downlight | Lensed WW | Surface Cylinder | Pendant Cylinder | Wall Cylinder | Wall Adjustable Cylinder

NOM RoHS COMPLIANT WET LOCATION

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

gotham | IVO™

IVO™ 4" Round Cylinder Pendant Mount

Luminaire Type:

Catalog Number:

EXAMPLE: IVO4CYL PC D 15LM 35K 80CRI MD MIN1 MVOLT ZT L5 JBX CAN C120 P AR LD DWH
EXAMPLE: IVO4CYL PC WW 20LM 35K 80CRI MIN1 MVOLT EZT L5 JBX CAN45 S10 LW BR LSS DBL

ORDERING INFORMATION

Series	Mounting Option	Function	Lumen Packages	Kelvin Temperature	Color Rendering Index	Distribution[3]
IVO4CYL IVO 4" Round Cylinder	PC Pendant Mount Cylinder	D Downlight WW Wall Wash	05LM[1] 500 Lumens 07LM 700 Lumens 10LM 1000 Lumens 15LM 1500 Lumens 20LM 2000 Lumens 25LM 2500 Lumens 30LM 3000 Lumens 35LM 3500 Lumens 40LM 4000 Lumens 45LM 4500 Lumens	27K 2700K 30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80+ CRI 90CRI[2] 90+ CRI, R9 50+ 95CRI[2] 95+ CRI, R9 80+	Narrow / Flood[4] 10D 10° 30D 30° 50D 50° 15D 15° 35D 35° 55D 55° 20D 20° 40D 40° 60D 60° 25D 25° 45D 45° General Illumination / Batwing MD Medium Batwing (0.8 s/mh, 60°) MWD Medium Batwing Wide (1.0 s/mh, 65°) WD Wide Batwing (1.2 s/mh, 75°)

Dimming Level	Voltage	Control Input[6]	Cylinder Length	Mounting Style
MIN10 Min 10% Dim Level MIN1 Min 1% Dim Level DARK Min 0.1% Dim Level, Dim-to-Dark	MVOLT Multi-Volt Input, 120V-277V 120 120V Input 277 277V Input 347[5] 347V Input	ZT[7] Generic 0-10V ELV[8] Phase Dimming (Forward/Reverse) (120V only) EZT EldoLED 0-10V DALI[9] DALI-2 DMX[9,10] DMX NLIGHT[11] Wired controls by nLight NLTAIR2[11] Wireless controls by nLight NLIGHTER[11] Wired controls by nLight with UL924 listed emergency operation NLTAIREM2[11] Wireless controls by nLight with UL924 listed emergency operation	L5[12] Shallow 5" Cylinder L9 Standard 9" Cylinder L14 Long 13-5/8" Cylinder L16 Extra Long 16" Cylinder	JBX Integral driver, Recessed or Surface J-box JBXCC Integral driver, Surface J-box with conduit covers SGB[13] Surface Gear Box, Recessed or Surface J-Box SGBCC[13] Surface Gear Box, Surface J-box with conduit covers

Canopy Cover	Pendant Length / Type	Fusing	Emergency Pack[16]	Wet/IP Listing
CAN Canopy, 5° hang straight swivel CAN45[14] Canopy, 45° hang straight swivel	S2 2ft x ø1/2" stem S4 4ft x ø1/2" stem S6 6ft x ø1/2" stem S8 8ft x ø1/2" stem S10 10ft x ø1/2" stem S12 12ft x ø1/2" stem S16 16ft x ø1/2" stem S20 20ft x ø1/2" stem C120[15] 10ft x ø5/16" cord C180[15] 15ft x ø5/16" cord C240[15] 20ft x ø5/16" cord	(blank) No Options SF Single Fuse, specify 120V or 277V	(blank) No Emergency Pack E7W[17] Emergency battery pack, Constant Power, Title 20 compliant, user selectable Self-Diagnostics, AC Activate with Integral Test Switch. E7WR 7W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) E10WR 10W Emergency battery pack, Constant Power, Title 20 Compliant, User selectable Self-Diagnostic, AC Activate with Remote Test Switch (Sidecar) E15WR 15W Emergency battery pack, Constant Power, Title 20 Compliant with Remote Test Switch (Sidecar)	(blank) Damp Location WL[18] Wet Location

Trim Style	Trim Color	Baffle Color	Trim Lens	Trim Finish[20]	Cylinder Color	
P[4] Parabolic Trim LW[19] Lensed Wall Wash BEV[20] Bevel Trim	AR Clear Anodized BR Black Anodized GR Gold Anodized PR Pewter Andodized WTR Wheat Anodized WR[20] White Paint WRAMF[20] White with Anti-Microbial Paint WMR[20] Soft White Paint BZR[20] Dark Bronze Paint TRALTBD[21] RAL Paint TCPCTBD Custom Paint	(blank) non-Bevel ARS Clear Anodized Semi-Specular WMRS Soft White BRS Black Semi-Specular BRD Black Diffuse	(blank) no lens SLG Solite Lens CLR Clear Lens	LSS Semi Specular LS Specular LD Matte Diffuse	DWH Gloss White DBL Matte Black DNA Gloss Natural Aluminum DWHAMF Gloss White Anti-Microbial DMB Matte Medium Bronze DDB Gloss Dark Bronze DSS Gloss Sandstone DGC Gloss Charcoal Grey DTG Gloss Tennis Green DBR Gloss Bright Red DSB Gloss Steel Blue	DDBT Textured Dark Bronze DBLB Textured Black DWHG Textured White DBNH Textured Bronze DNAT Textured Natural Aluminum DSST Textured Sandstone DSPD Textured Dark Grey DSPE Textured Green DSPH Textured Light Red RALTBD[21] RAL Paint CPC Custom Paint

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

ORDERING NOTES

1. 05LM only available with L5 Cylinder Length and ZT or ELV. 05LM not available with E7W.
2. 90CRI not available with 50K Kelvin Temperature. 95CRI not available with 35K, 40K or 50K Kelvin Temperature.
3. Not available with WW style Function.
4. Not available with L5 Cylinder Length.
5. 347 only available with ZT Control Input. Min10LM-Max 45LM. Not available with nLight, Emergency or SF Options. Not available with L5 Cylinder Length.
6. Refer to Tech-240 for compatible dimmers.
7. ZT not available with DARK.
8. ELV only available with MIN1 and 120 volt.
9. DALI and DMX only available with DARK.
10. DMX not available with L5 Cylinder Length. Only available with SGB or SGBCC Mounting.
11. nLight controls are provided with each fixture and can be remote mounted or mounted to the junction box. Wired NLIGHT and NLIGHTER controls include nPS 80 EZ dimming pack. Wireless NLTAIR2 and NLTAIREM2 controls include rPP20 power pack. Includes EZT driver. See Tables of Use on page 10.
12. L5 available up to 30LM max. Not available with E7W or 347.
13. Only available with DMX Control Input option.
14. Not available with SGB or SGBCC.
15. Power Mounting Cords are field cuttable. Not available with WW style Function. Color is determined by Architectural Color: White for DWHG, DWH, DWHAMF; Black for DBL, DBLB; Gray for all other color options.
16. Not available with 05LM, 25LM or 30LM with EZT or DALI control input for L5 Cylinder Length. Not available with 05LM with EZT or DALI Control Input for L9, L14 or L16 Cylinder Lengths.
17. E7W only available with ZT or ELV. Not available with 347, C120, C180, or C240. Available up to 20LM max for L9. Available up to 35LM max for L14 L16. E7W with WL available up to 15LM max.
18. WL only available with JBX. Not available with DMX or Emergency options. Min 05LM-30LM max for ZT or ELV in L5 Cylinder Lengths. Min 07LM-Max 20LM for EZT or DALI in L5 Cylinder Lengths. 30LM max for ZT or ELV in L9, L14 or L16 Cylinder Lengths. 07LM-30LM max for EZT or DALI in L9, L14 or L16 Cylinder Lengths.
19. LW not available with D style Function.
20. Optical finishes are not available with WR, WRAMF WMR and BZR trim colors.
21. Replace with applicable RAL number and finish when ready to order. See RAL BROCHURE for available color options.

ACCESSORIES – order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
GOTHAM IVO REFLECTOR COLOR KIT	Trim colors & finishes sample kit for standard IVO anodized and painted trim color options.
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting
CYLSTBL KIT	Stabilization Kit for securing pendant stem fixtures
IVO40PTC D MD	Field Replaceable 4" Downlight Optic, Medium Batwing Distribution, 0.8 s/mh, for L9-L16 Cylinder Lengths only
IVO40PTC D MWD	Field Replaceable 4" Downlight Optic, Medium Wide Batwing Distribution, 1.0 s/mh, for L9-L16 Cylinder Lengths only
NO40PTC D WD	Field Replaceable 4" Downlight Optic, Wide Batwing Distribution, 1.2 s/mh, for L9-L16 Cylinder Lengths only
IVO40PTC D 10D	Field Replaceable 4" Downlight Optic, 10°, for L9-L16 Cylinder Lengths only
IVO40PTC D 15D	Field Replaceable 4" Downlight Optic, 15°, for L9-L16 Cylinder Lengths only
IVO40PTC D 20D	Field Replaceable 4" Downlight Optic, 20°, for L9-L16 Cylinder Lengths only
IVO40PTC D 25D	Field Replaceable 4" Downlight Optic, 25°, for L9-L16 Cylinder Lengths only
IVO40PTC D 30D	Field Replaceable 4" Downlight Optic, 30°, for L9-L16 Cylinder Lengths only
IVO40PTC D 35D	Field Replaceable 4" Downlight Optic, 35°, for L9-L16 Cylinder Lengths only
IVO40PTC D 40D	Field Replaceable 4" Downlight Optic, 40°, for L9-L16 Cylinder Lengths only
IVO40PTC D 45D	Field Replaceable 4" Downlight Optic, 45°, for L9-L16 Cylinder Lengths only
IVO40PTC D 50D	Field Replaceable 4" Downlight Optic, 50°, for L9-L16 Cylinder Lengths only
IVO40PTC D 55D	Field Replaceable 4" Downlight Optic, 55°, for L9-L16 Cylinder Lengths only
IVO40PTC D 60D	Field Replaceable 4" Downlight Optic, 60°, for L9-L16 Cylinder Lengths only
IVO4SOPTIC D MD U	Field Replaceable Optic, Medium Distribution, for L5 Cylinder Length only
IVO4SOPTC D MWD U	Field Replaceable Optic, Medium Wide Distribution, for L5 Cylinder Length only
IVOSOPTC D WD U	Field Replaceable Optics, Wide Distribution, for L5 Cylinder Length only

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

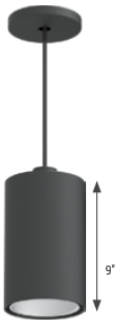
LENGTH AND TRIM OPTIONS

Cylinder Length

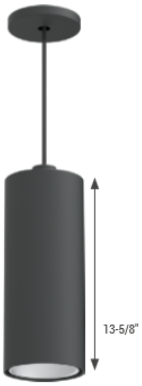
- Dimensions in inches [centimeters]
- L5 Cylinder has a 65° visual cut-off angle and trims and optics that are not interchangeable with the other Cylinder lengths

L5 - Shallow

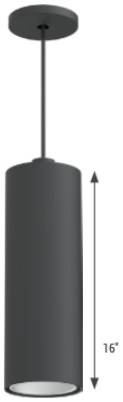
L9 - Standard



L14 - Long



L16 - Extra Long

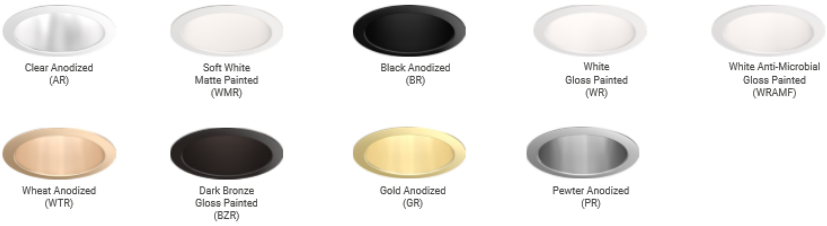


Trim Style

Optical Finish

Clear Anodized shown.

Trim Color



Parabolic shown.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

ARCHITECTURAL COLORS

Textured Colors

Gloss Colors

Matte Colors

Note: These colors were carefully reproduced to give as true a depiction as possible of the finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please contact a Gotham representative for an Architectural Color Chip Kit (GCOLORS KIT), consisting of Powder-Coated and Plated Finishes.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

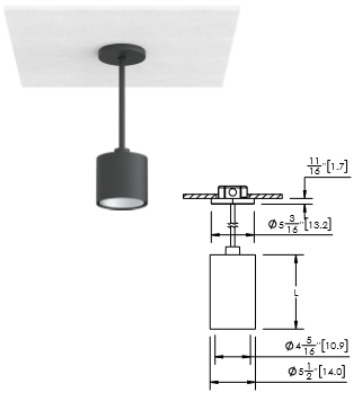
DIMENSIONAL DATA

Pendant Rigid Stem and Cord Mounting Options

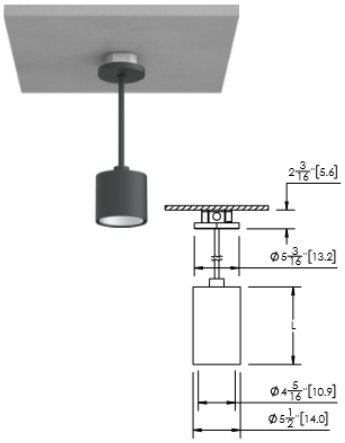
- Dimensions in inches [centimeters]
- Rigid Stems are Ø½" made of 2ft and 4ft field cuttable sections with no threading required, orderable from 2ft (S2) up to 20ft (S20).
- Powered Mounting Cords are Ø5/16" field cuttable down to 4" and include integrated Aircraft Cable (patent pending) for mechanical support without visible cable, orderable from 10ft (C120) up to 20ft (C240).
- J-boxes available by others (see Compatibility Table).

CYLINDER LENGTH (L)	DIMENSIONS INCHES (CM)
L5	5" (12.7)
L9	9" [22.9]
L14	13-5/8" [34.6]
L16	16" [40.6]

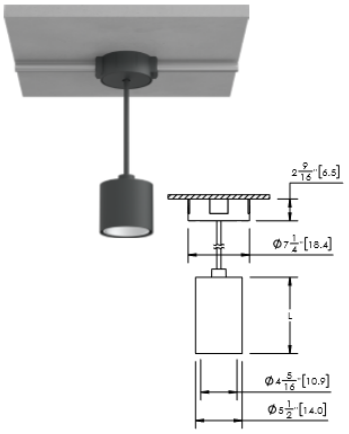
Canopy with Recessed J-box (JBX)



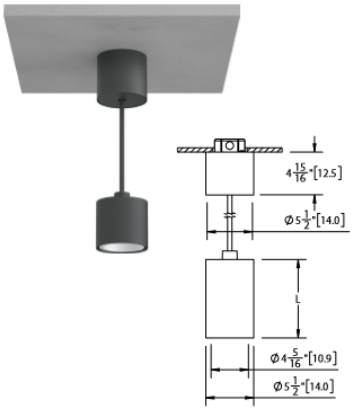
Canopy with Surface J-box (JBX)



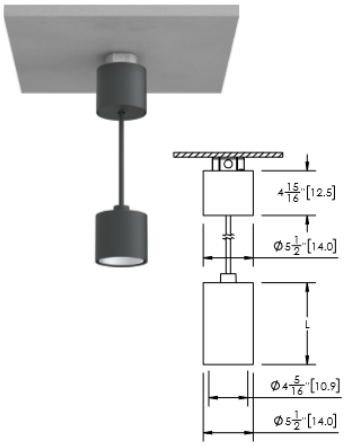
Conduit Cover Canopy with Surface J-box (JBXCC)



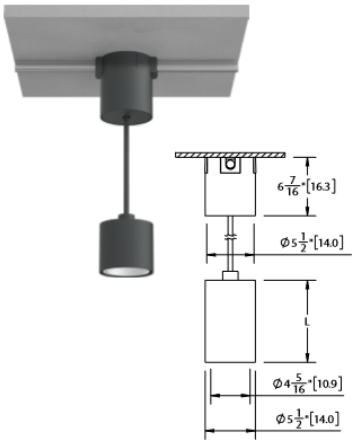
Surface Gear Box with Recessed J-box (SGB)



Surface Gear Box with Surface J-box (SGB)



Conduit Cover Surface Gear Box with Surface J-Box (SGBCC)



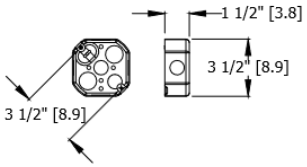
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

JUNCTION BOX AND CANOPY

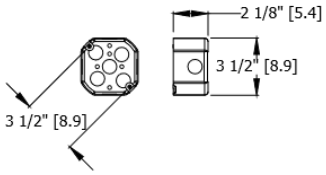
Junction Box and Canopy Details

- Dimensions in inches [centimeters]
- Options shown are available for Rigid Stem Mount or Powered Mounting Cord.
- J-boxes available by others.

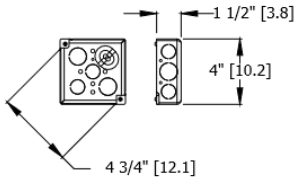
4" Octagonal j-box, 1-½" deep



4" Octagonal j-box, 2-1/8" deep

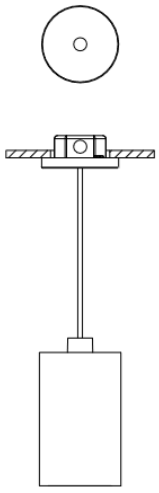


4" Square j-box, 1-½" deep

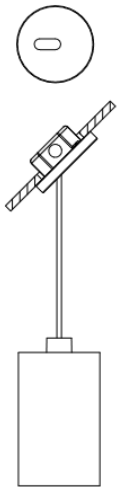


J-box Compatibility Matrix		Cylinder Configurations	
		JBX	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep	✓	✓
	4" Octagonal 4x4x2.125 deep	✓	×
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	×

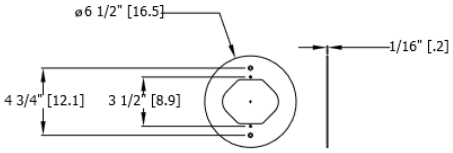
Standard Canopy (CAN) with 5° hang straight swivel



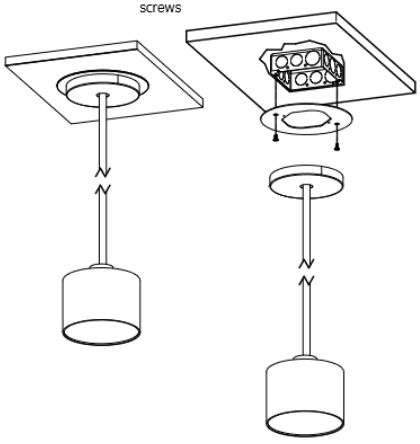
Canopy with Slot (CAN45) with 45° hang straight swivel



Cylinder Adaptor Plate (CYLJBOXADPT 4SQ20CT)



Includes 2 mounting screws



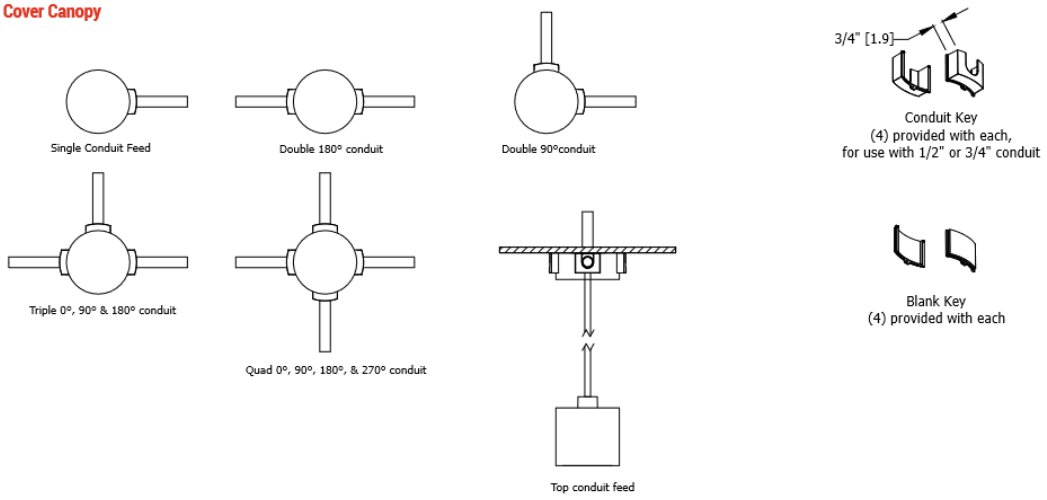
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

JUNCTION BOX AND CANOPY

Conduit Covers and Emergency Battery Sidecar

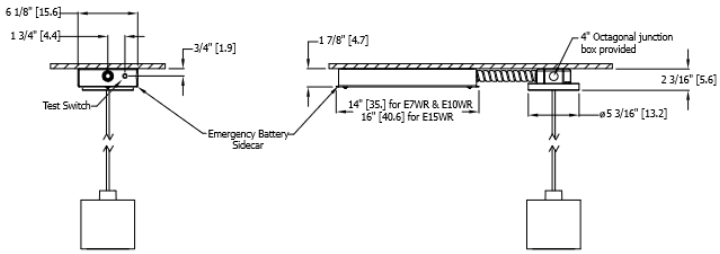
- Dimensions in inches [centimeters]
- Options shown are available for Rigid Stem Mount or Powered Mounting Cord.
- J-boxes available by others.

Conduit Cover Canopy

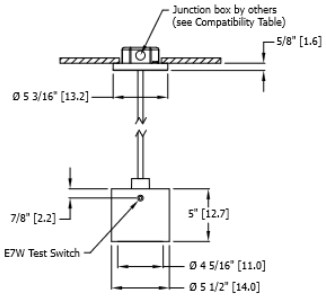


Emergency Battery Sidecar Enclosure

Emergency Battery Remote Test Switch (E7WR, E10WR, E15WR)



Emergency Battery Integral Test Switch (E7W)



How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output Power/Wattage of Emergency Battery Driver (E7WR* = 7W, E10WR* = 10W, E15WR* = 15W)

LPW = Lumen per Watt rating of luminaire based on Ordering Code selections

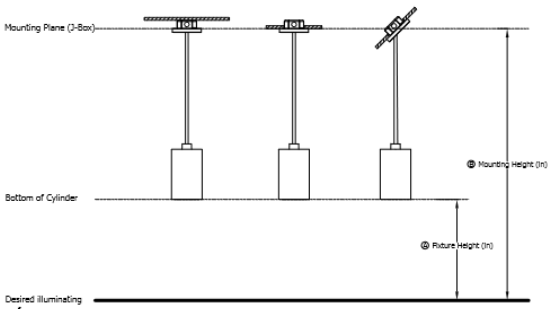
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

MOUNTING HEIGHT FORMULAS

Mounting Height Calculations for Field Cuttable Pendants

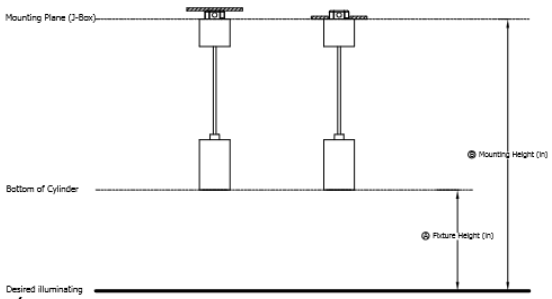
- Dimensions in inches [centimeters]
- J-boxes available by others.

Formulas for JBX/JBXCC



Rigid Stem Length=Ⓑ-Ⓐ- 5"
Mounting Cord Length=Ⓑ-Ⓐ

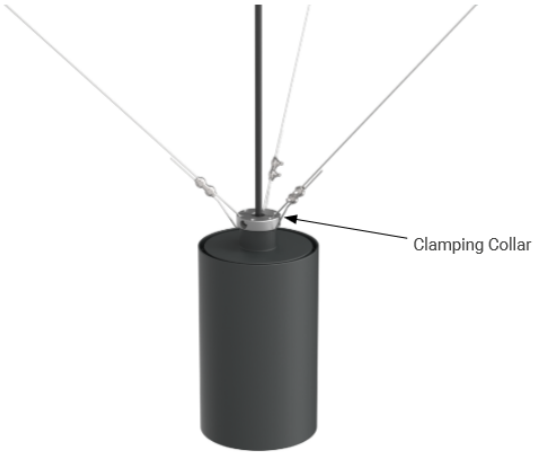
Formulas for SGB/SGBCC



Rigid Stem Length=Ⓑ-Ⓐ- 9"
Mounting Cord Length=Ⓑ-Ⓐ- 4"

Stabilization Kit

- Stabilization Kit (CYLSTBL KIT) offers additional support for applications where wind may be a factor and the Cylinder needs to be secured, for Rigid Stem Mount only.
- Clamping Collar consists of 2 half stem collars made of 304 grade stainless steel that clamp Rigid Stem using the socket head cap screw provided.
- 3 cables, ø1/16" x 20ft long and made of 304 grade stainless steel Aircraft Cable, support the Clamping Collar at one end and are anchored to the mounting surface at the other end (anchors by others).
- The Stabilization Kit is designed to withstand 90mph winds for 3 seconds per ASCE 7-10, MRI 50-year (fixture EPA is 0.2 sq ft).



GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

SPECIFICATIONS

Optical System
- Bounding Ray™ optical design delivers low brightness apertures for a comfortable lighting experience. Bounding Ray™ optical design ensures no source image up to cut-off angle, minimizing glare.
- 45° visual cut-off angle to source for L9, L14 and L16 lengths and 65° visual cut-off for L5 length per CIE 117-1995 Discomfort Glare in Interior Lighting (UGR FAQ)
- Top-Down Flash characteristics avoid flash on trim until source becomes visible.
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture. Available with 0.8, 1.0, and 1.2 spacing-to-mounting-height ratio (s/mh).
- Clean beams with soft transitions from narrow spot 10° up to wide flood 60° distributions and available every 5°.
- Optics are field changeable. However, L5 Cylinder Length optics aer not interchangeable with other Cylinder Length optics.

LED Light Engine
- Perfect Color™ consistency within 1/2-step MacAdam Ellipse using proprietary pick and place algorithm.
- 90% lumen maintenance at 55,000 hours.
- Available in 80, 90, or 95 CRI. 90 CRI has R9 greater than 50, 95 CRI has R9 greater than 80.

Trims
- Trims are field changeable via twist-lock (tool-free). However L5 Cylinder Length trims are not interchangeable with other Cylinder Lengths.
- Trims are available in 9 colors and 3 surface finishes (standard)
- Custom RAL and Paint colors available upon request.
- Trim lenses are made of Tempered Glass

Electrical
- 120, 277, 347, or Multi-Volt (MVOLT) 120-277 VAC input at 50/60 Hz.
- Power Factor > 85%.
- Input wires 18 AWG, 600V minimum, solid copper.

EMI/RFI
- EMI/RFI per FCC Title 47 CFR, Part 15, Class A rated standard.
- EMI/RFI per FCC Title 47 CFR, Part 15, Class B rated for Phase Dimming driver (ELV) except when used with Emergency Battery (E7WR, E10WR, E15WR) or at 15LM and above.

Controls (Optional)
- Luminaire can be equipped with interface for nLight wired, allowing it to communicate over an nLight network. nLight wired options ship with an nPS 80 EZ power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Couple with nLight-enabled sensors, power packs, or WallPods using CAT-5 cabling to create an nLight Control Zone. Link Control Zone to a Gateway directly or via a Bridge for remote status monitoring and control using SensorView software.
- Luminaire can be equipped with interface for nLight Air, allowing it to communicate over the wireless nLight control platform. nLight Air options ship with an rPP20 power pack to be mounted to a plenum j-box through (via 1/2" knockout) and connected to the Fixture control wires. Can be paired to other luminaires and wall switches through CLAIRITY+, a mobile app, which allows individual fixture control.

Dimming
- Luminaire Is capable of continuous dimming without perceivable flicker (stroboscopic) as measured by flicker index (ASNI/IES RP-16-10).
- Available dimming ranges include: 100%-10% (MIN10), 100%-1% (MIN1), and 100%-0.1% (DARK) of rated lumen output.
- Available with smooth shut off function from minimum dimming level to 0%.
- EldoLED drivers (EZT, DALI) conform to IEEE P1789 standards.
- Drivers are inaudible in 24dB environment and stable even when input voltage conditions experience typical commercial environment fluctuations.

Emergency Battery (Optional)
- Luminaires equipped with battery pack (E7W, E7WR, E10WR, E15WR) comply with NFPA 101 (Life Safety Code) and deliver constant light output for a duration of 90 minutes minimum with AC power loss.
- Emergency batteries with Remote Test Switch (E7WR, E10WR, E15WR) are mounted to ceiling via remote enclosure (sidecar).
- Emergency battery is CEC T20 compliant.

Installation
- Rigid Stems are field cuttable with no threading required.
- Rigid Stem lengths consist of 2ft and 4ft sections.
- Powered Mounting Cords are field cuttable down to 4" and include integrated Aircraft Cable (patented) for mechanical support without visible cable.
- Luminaire can be installed to 4" Octagonal j-box (1-1/2" or 2-1/8" deep depending on ordering configuration).
- Luminaire can be installed to 4" Square j-box (1-1/2" deep) when used with Cylinder Adaptor Plate (CLYLJBOXADPT 4SQ20CT).
- Optional, field configurable Conduit Covers are available and match Cylinder finish and diameter.

Construction
- Heavy-gauge extruded Aluminum construction.
- Reflector design allows air flow across heatsink to improve thermal management.
- Light Engine and Driver are field replaceable and serviceable from below the ceiling.

Listings
- Fixtures are CSA certified to meet US and Canadian standards.
- All fixtured are manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" per UL.
- Damp Location standard.
- Wet Location available.

Photometrics
- All photometry is conducted by IESNA standard LM-79-08 in an accredited lab.
- LEDs are tested to LM-80 standards. Lumen maintenance is calculated via TM-21.

Warranty
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:
- Actual performance may differ as a result of end-user environment and application.
- All values are design or typical values, measured under laboratory conditions at 25 °C.
- The product images shown are for illustration purposes only and may not be an exact representation of the product.

© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

TABLES OF USE

Dimming Configurations

Dimming Level		Control Input	Dimming Level	Driver Dim Curve	Recommended Control Dim Curve
MIN10	+	ZT	100% to 10%	Linear	Linear/Logarithmic
	+	EZT	100% to 10%	Linear	Linear/Logarithmic
MIN1	+	ZT	100% to 1%	Linear	Linear/Logarithmic
	+	EZT	100% to 1%	Linear	Linear/Logarithmic
	+	ELV	100% to 1%*	n/a	n/a
DARK	+	EZT	100% to 0.1%	Logarithmic	Linear
	+	DMX	100% to 0.1%	Square	Linear
	+	DALI	100% to 0.1%	Logarithmic	Linear

* ELV Minimum Dimming level depends on dimmer and dimmer load

Night Configurations

Dimming Level		Control Input	Dimming Level	Control Provided	Driver Provided
MIN10	+	NLIGHT	100% to 10%	NPS 80 EZ	eldoLED ECOdrive
	+	NLIGHTER	100% to 10%	NPS 80 EZ ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 10%	RPP20	eldoLED ECOdrive
	+	NLTAIREM2	100% to 10%	RPP20 EM	eldoLED ECOdrive
MIN1	+	NLIGHT	100% to 1%	NPS 80 EZ	eldoLED ECOdrive
	+	NLIGHTER	100% to 1%	NPS 80 EZ ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 1%	RPP20	eldoLED ECOdrive
	+	NLTAIREM2	100% to 1%	RPP20 EM	eldoLED ECOdrive
DARK	+	NLIGHT	100% to 0.1%	NPS 80 EZ	eldoLED SOLOdrive
	+	NLIGHTER	100% to 0.1%	NPS 80 EZ ER	eldoLED SOLOdrive
	+	NLTAIR2	100% to 0.1%	RPP20	eldoLED SOLOdrive
	+	NLTAIREM2	100% to 0.1%	RPP20 EM	eldoLED SOLOdrive

IVO4CYL D L5		Drivers:	Title 24, JA8 ZT, ELV	Energy Star EZT, ZT, ELV, DALI
DOWNLIGHT	80CRI	2700K		✓2
		3000K		✓2
		3500K		✓2
		4000K		✓2
		5000K		✓2
	90CRI	2700K		✓2,3
		3000K		✓2,3
		3500K	✓1	✓2,3
		4000K	✓1	✓2,3
	95CRI	2700K	✓1	
		3000K	✓1	

Applicable for L5 length Downlight Cylinders only.
1 - E7WR, E10WR, and E15WR are not T24 complaint.
2 - E7WR is not Energy Star complaint.
3 - 90CRI with 05LM and ELV or ZT is not Energy Star complaint.

IVO4CYL WW L5		Drivers:	Title 24, JA8 ZT, ELV	Energy Star EZT, ZT, ELV, DALI
WALL WASH	80CRI	2700K		✓1,2
		3000K		✓1,2
		3500K		✓1,2
		4000K		✓1,2
		5000K		✓1,2
	90CRI	2700K		✓1,2
		3000K		✓1,2
		3500K		✓1,2
		4000K		✓1,2
	95CRI	2700K		
		3000K		

Applicable for L5 length Wall Wash Cylinders only.
1 - E7WR is not Energy Star complaint.
2 - 05LM and 07LM are not Energy Star complaint.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

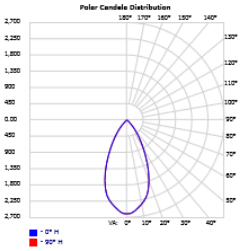
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

PHOTOMETRY

MD Medium Beam

IVO4CYL PC D 20LM 35K 80CRI MD L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 1920, LPW: 94, S/MH: ..8, Test No: 24-850-22P3302



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

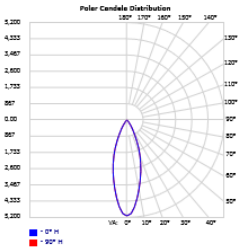
Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

35 Degree Beam

IVO4CYL PC D 20LM 35K 80CRI 35D L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 2044.6, LPW: 100, S/MH: .54, Test No: 24-850-34P1217



Candela Summary	
0°	5116
10°	3734
20°	2039
30°	675
40°	120
50°	14
60°	4
70°	2
80°	1
90°	0

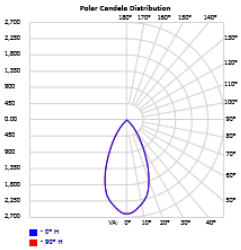
Zonal Lumen Summary		
Zone	Lumens	%
0-30	1778.1	87.0%
0-40	1992.7	97.5%
0-60	2040.2	99.8%
0-90	2044.6	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	79.94	4.8	4.8
10'	51.16	6	6
12'	35.53	7.2	7.2
14'	26.1	8.4	8.4
16'	19.99	9.6	9.6

50 Degree Beam

IVO4CYL PC D 20LM 35K 80CRI 50D L9/L14/L16 P AR LSS

Wattage: 20.5, Lumens: 1920.1, LPW: 94, S/MH: .8, Test No: 24-850-22P3310



Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

CRI/CCT Multiplier		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Trim Color and Finish Multiplier		
Trim Color	Trim Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

UGR (70% 50% 20% reflectance using a 4H x 8H room size)						
Lumen Package	Crosswise			Endwise		
	MD	MWD	WD	MD	MWD	WD
05LM	7.9	4.9	4.9	7.9	4.9	4.9
07LM	9.2	6.2	6.2	9.2	6.2	6.2
10LM	10.3	7.3	7.3	10.3	7.3	7.3
15LM	11.4	8.4	8.4	11.4	8.4	8.4
20LM	12.3	9.4	9.3	12.3	9.4	9.3
25LM	13	10.1	10.1	13	10.1	10.1
30LM	13.6	10.6	10.6	13.6	10.6	10.6

*UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.

**Calculated using an AR (Clear reflector) with LSS (Semi-Specular) finish

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

PHOTOMETRY

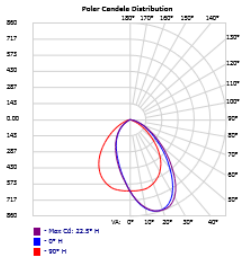
Superior Performance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	340	507	683	1025	1357	1687	1884	2285	2618	2921
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	66	69	69	69	66	63	63	66	63	64

*Based on Lensed Wall Wash performance: 3500K 80CRI MD P AR LSS, for L9, L14, and L16. See IES files available online for L5 performance.

LW Lensed Wall Wash

IVO4CYL PC WW 20LM 35K 80CRI L9/L14/L16 LW AR LSS **Wattage: 20.5, Lumens: 1357.4, LPW:66, S/MH: 1.5, Test No: 24-824-1P224**



Candela Summary	
0°	633
10°	800
20°	851
30°	759
40°	550
50°	346
60°	199
70°	101
80°	32
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	503.8	37.1%
0-40	804.4	59.3%
0-60	1238.8	91.3%
0-90	1357.4	100.0%

CRI/CCT Multiplier		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Trim Color and Finish Multiplier		
Trim Color	Trim Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

NLIGHT

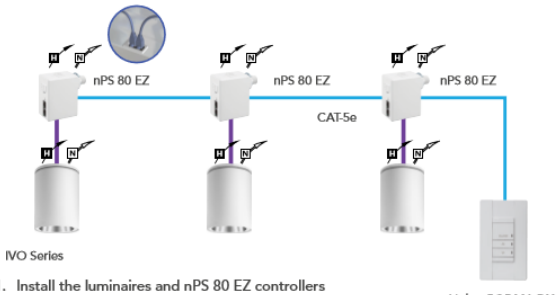
nLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Controls



1. Install the luminaires and nPS 80 EZ controllers and make the low-voltage connections
2. Install the nLight Wired wall switch
3. Connect the nLight devices using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Controls

1. Install the luminaires and rPP20 power/relay packs
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY™+ mobile app to pair the luminaires with the wall switch and if desired, customize the device settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 11/10/25 Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	LDN4CYL-30/20-L04-AR-LSS-MVOLT-EZ1-ACC-DBL
TOTAL WATTS	22.5
VOLTAGE	120-277
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	7.5" x 7.5" x 12.5"
FINISH	Black
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	1932
ANTICIPATED LIFE	60,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Pendant mount fixed cylinder with one (1) LED lighting source, 1932 delivered lumens, 3000K color engine, 80+ CRI, 55° optic and integral driver. Cylinder should operate on 120 -277 voltage and be supplied with a 0-10v control option down to 1% and include a minimum 5-year warranty with a 60,000 hour anticipated life. Cylinder to have black finish. Cylinder should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

C72

Catalog Number	LDN4CYL 30/20 L04 AR LSS MVOLT EZ1 ACC DBL
Notes	
Type	

LDN4CYL

4" CYLINDER
Non-IC

FEATURES & SPECIFICATIONS

INTENDED USE — Typical applications include corridors, lobbies, conference rooms and private offices.

CONSTRUCTION — Heavy-gauge aluminum housing.

Ceiling mount for direct installation to 4" octagonal or square junction box.

Pendant mount entry for 3/8" National Pipe Thread stem; wires supplied by others.

Textured polyester powder paint finish standard.

Multiple ceiling, pendant, cord, and wall mount options available.

OPTICS — LEDs are binned to a 3-step SDCM; 80 CRI minimum. 90 CRI optional.

LED light source concealed with diffusing optical lens.

General illumination lighting with 1.0 S/MH and 55° cutoff to source and source image.

Self-flanged anodized reflectors in specular, semi-specular, or matte diffuse finishes. Also available in white and black painted reflectors.

ELECTRICAL — Multi-volt (120-277V, 50/60Hz) 0-10V dimming drivers mounted to junction box, 10% or 1% minimum dimming level available.

347V available option; transformer must be field-installed to an accessible remote-mounted junction box.

0-10V dimming fixture requires two (2) additional low-voltage wires to be pulled.

70% lumen maintenance at 60,000 hours.

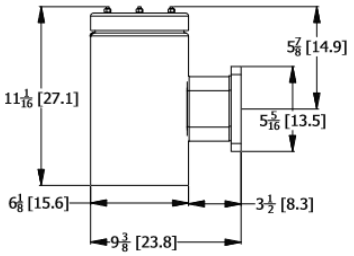
LISTINGS — Certified to US and Canadian safety standards. Damp location standard (wet location, covered ceiling optional).

GOVERNEMENT PROCUREMENT — BAA – Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

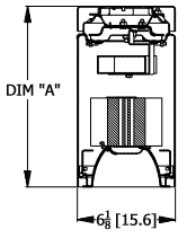
WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

* All dimensions are inches (centimeters) unless otherwise noted.



LDN4 CYLINDER WALL MOUNT



LDN4 CYLINDER

LDN4CYL 3500K AR LSS 80CRI			
Nominal	**Lumens**	**Wattage**	**Lm/W**
500	523.6	5.74	91.2
750	751.1	8.6	87.3
1000	1045	10.58	98.8
1500	1512	17.5	86.4
2000	2006	22.12	90.7
2500	2551	26.1	97.7
3000	3007	32.1	93.7
4000	4212	43	98.0

DIMENSION TABLE	
STYLE	**DIM "A"**
CEILING MOUNT (FCM)	10-13/16
CEILING MOUNT WET LOCATION (FCM WL)	10-13/16
PENDANT MOUNT (PM)	10
PENDANT MOUNT WET LOCATION (PM WL)	11
CABLE MOUNT (ACC)	9-13/16

LDN4CYL

Design Select options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example:** LDN4CYL 35/15 LO4AR LSS MVOLT EZ1 FCM DWHG

LDN4CYL

Series	Color temperature	Lumens	Aperture/Trim Color		Finish	Voltage
LDN4CYL 4" cylinder	27/ 2700K	05 500 lumens	LO4 Downlight	AR Clear	LSS Semi-specular	MVOLT Multi-volt
	30/ 3000K	07 750 lumens	LW4[1] Wallwash	WR ‡ White	LD Matte diffuse	120 120V
	35/ 3500K	10 1000 lumens		BR ‡ Black	LS Specular	277 277V
	40/ 4000K	15 1500 lumens				
	50/ 5000K	20 2000 lumens				

Driver[3]	Mounting	Options	Architectural Colors ‡
GZ10 0-10V driver dims to 10%	FCM Ceiling mount	SF[6] Single fuse	DWHG Matte white (standard)
GZ1 0-10V driver dims to 1%	WM Wall mount	90CRI High CRI (90+)	DDB Dark bronze
EZ1 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1%	PM ‡ Pendant 3/8" thread mount	WL ‡ Wet location	DBL Black
	ACC ‡ 10ft aircraft cable and cord mount	nLight Options:	DWH Glossy white
	ACC180 ‡ 15ft aircraft cable and cord mount	NPP16D ‡ nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).	DMB Medium bronze
		NPP16DER ‡ nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.	DNA Natural aluminum
		NPS80EZ ‡ nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1).	DSS Sandstone
		NPS80EZER ‡ nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1). ER controls fixtures on emergency circuit.	DGC Charcoal grey
			DTG Tennis green
			DBR Bright red
			DSB Steel blue

Accessories: *Order as separate catalog number. (shipped separately)*

CYS ‡	3/8" stem and canopy with 5" "hang straight" swivel
CRS ‡	3/8" stem and canopy with 45° swivel
SDT 347/120 75VA12 ‡	347V Step-down transformer

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

(Maximum order quantity for design select lead times is 50)

‡ Option Value Ordering Restrictions

Option value	Restriction
LW4	Not available in ACC mount.
WR, BR	Not available with finishes.
PM	Supplied with 10" supply and dimming connections.
ACC, ACC180	White cord supplied with white housings. All other finishes supplied with black cord.
SF	Must specify voltage 120V or 277V.
NPP16D, NPP16DER, NPS80EZ, NPS80EZER	Specify voltage. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed. Interface remote mounted. Access panel (supplied by others) recommended. See UL 924 Sequence of Operation table.
WL	Not available with ACC & ACC180 mounting options.
Architectural Colors	Additional architectural colors available; see www.lithonia.com/archcolors.
CYS, CRS	Color and length of stem must be specified (from 6" to 240" in even increments in maximum sections of 48"). Ex.: CYS06 DWHG. Ceiling attachment for interior use. Consult factory for exterior use.
SDT 347/120 75VA	Must be field-installed to an accessible remote-mounted junction box

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

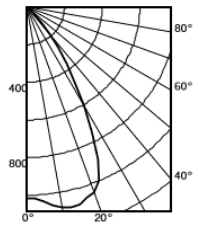
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 04/11/25

LDN4CYL

PHOTOMETRY

Distribution Curve | **Distribution Data** | **Output Data** | **Coefficient of Utilization** | **Illuminance Data at 30" Above Floor for a Single Luminaire**

LDN4 35/10 LO4AR, input watts: 10.58, delivered lumens: 1085.2, LM/W = 102.57, spacing criterion at 0= 1.04, test no. ISF 30712P424.



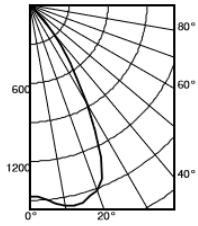
	Ave	Lumens
0	1017	
5	1039	101
15	1084	304
25	895	395
35	369	232
45	52	51
55	1	2
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	799.7	73.7
0° - 40°	1031.5	95.1
0° - 60°	1084.7	100.0
0° - 90°	1085.2	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	1085.2	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	70% 50%	70% 30%	70% 10%	20% 50%	20% 30%	20% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	79	73	69	79	73	69	77	72	68
7	75	69	64	74	68	64	73	68	64
8	70	64	60	70	64	60	69	63	60
9	66	60	56	66	60	56	65	60	56
10	63	57	53	62	57	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	33.6	5.8	16.8	8.9	3.4
10.0	18.1	7.9	9.0	12.2	1.8
12.0	11.3	10.0	5.6	15.4	1.1
14.0	7.7	12.1	3.8	18.6	0.8
16.0	5.6	14.2	2.8	21.9	0.6

LDN4 35/15 LO4AR, input watts: 17.5, delivered lumens: 1570.1, LM/W = 89.72, spacing criterion at 0= 1.04, test no. ISF 30712P429.



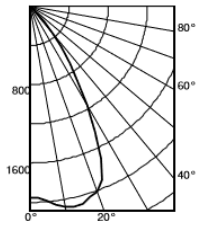
	Ave	Lumens
0	1472	
5	1503	146
15	1569	440
25	1295	571
35	534	335
45	75	74
55	1	3
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1157.1	73.7
0° - 40°	1492.5	95.1
0° - 60°	1569.4	100.0
0° - 90°	1570.1	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	1570.1	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	70% 50%	70% 30%	70% 10%	20% 50%	20% 30%	20% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	79	73	69	79	73	69	77	72	68
7	75	69	64	74	68	64	73	68	64
8	70	64	60	70	64	60	69	63	60
9	66	60	56	66	60	56	65	60	56
10	63	57	53	62	57	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	48.7	5.8	24.3	8.9	4.9
10.0	26.2	7.9	13.1	12.2	2.6
12.0	16.3	10.0	8.2	15.4	1.6
14.0	11.1	12.1	5.6	18.6	1.1
16.0	8.1	14.2	4.0	21.9	0.8

LDN4 35/20 LO4AR, input watts: 22.12, delivered lumens: 2083.1, LM/W = 94.17, spacing criterion at 0= 1.04, test no. ISF 30712P434.



	Ave	Lumens
0	1952	
5	1994	193
15	2081	584
25	1718	758
35	709	445
45	99	98
55	2	4
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1535.2	73.7
0° - 40°	1980.1	95.1
0° - 60°	2082.1	100.0
0° - 90°	2083.1	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	2083.1	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	70% 50%	70% 30%	70% 10%	20% 50%	20% 30%	20% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	79	73	69	79	73	69	77	72	68
7	75	69	64	74	68	64	73	68	64
8	70	64	60	70	64	60	69	63	60
9	66	60	56	66	60	56	65	60	56
10	63	57	53	62	57	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	64.5	5.8	32.3	8.9	6.5
10.0	34.7	7.9	17.4	12.2	3.5
12.0	21.6	10.0	10.8	15.4	2.2
14.0	14.8	12.1	7.4	18.6	1.5
16.0	10.7	14.2	5.4	21.9	1.1

LUMEN OUTPUT MULTIPLIERS - FINISH			
	Clear (AR)	White (WR)	Black (BR)
Specular (LS)	1.0	N/A	N/A
Semi-specular (LSS)	0.950	N/A	N/A
Matte diffuse (LD)	0.85	N/A	N/A
Painted	N/A	0.87	0.73

LUMEN OUTPUT MULTIPLIERS - CCT					
	2700K	3000K	3500K	4000K	5000K
80CRI	0.950	0.966	1.000	1.025	1.101

LUMEN OUTPUT MULTIPLIERS - CRI	
80	1.0
90	0.874

Notes

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 80 typical.

LITHONIA LIGHTING®

LDN4CYL

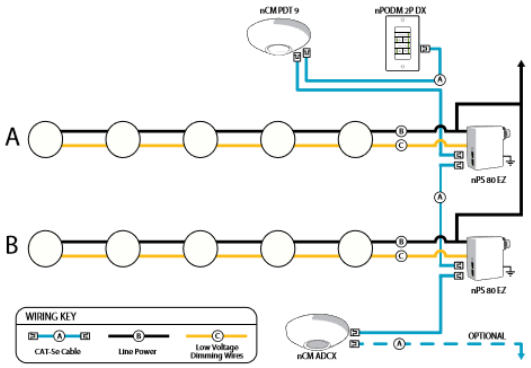
DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 04/11/25

LDN4CYL

ADDITIONAL DATA

COMPATIBLE 0-10V WALL-MOUNT DIMMERS		
MANUFACTURER	PART NO.	POWER BOOSTER AVAILABLE
Lutron®	Diva® DVTV	
	Diva® DVSCTV	
	Nova T® NTFTV	
	Nova® NFTV	
Leviton®	AWSMT-7DW	CN100
	AWSMG-7DW	PE300
	AMRMG-7DW	
	Leviton Centura Fluorescent Control System	
	IllumaTech® IP7 Series	
Synergy®	ISD BC	RDMFC
	SLD LPCS	
	Digital Equinox (DEQ BC)	
Douglas Lighting Controls	WPC-5721	
Entertainment Technology	Tap Glide TG600FAM120 (120V)	
	Tap Glide Heatsink TGH1500FAM120 (120V)	
	Oasis 0A2000FAMU	
Honeywell	EL7315A1019	EL7305A1010 (optional)
	EL7315A1009	
HUNT Dimming	Preset slide: PS-010-IV and PS-010-WH	
	Preset slide: PS-010-3W-IV and PS-010-3W-WH	
	Preset slide, controls FD-010: PS-IFC-010-IV and PS-IFC-010-WH-120/277V	
	Preset slide, controls FD-010: PS-IFC-010-3W-IV and PS-IFC-010-3W-WH-120/277V	
	Remote mounted unit: FD-010	
Lehigh Electronic Products	Solitaire	PBX
PDM Electrical Products	WPC-5721	
Starfield Controls	TR61 with DALI interface port	RT03 DALInet Router
WattStopper®	LS-4 used with LCD-101 and LCD-103	



nLight® Control Accessories:
Order as separate catalog number.
Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	Model number
On/Off	nPODM [color]
On/Off & Raise/Lower	nPODM DX [color]
Graphic Touchscreen	nPOD GFX [color]
Photocell controls	**Model number**
Dimming	nCM ADCX

Occupancy sensors	Model number
Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Wide view (PIR / dual tech)	nWV 16 / nWV PDT 16
Wall Switch w/ Raise/Lower (PIR / dual tech)	nWSX LV DX / nWSX PDT LV DX
Cat-5 cables (plenum rated)	**Model number**
10', CAT5 10FT	CAT5 10FT J1
15', CAT5 15FT	CAT5 15FT J1

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 04/11/25

EQUIPMENT

MANUFACTURER	LITHONIA LIGHTING
CATALOG NUMBER	LDN4CYL 30/20 L04 AR LSS MVOLT EZ1 ACC DBL
TOTAL WATTS	22.12
VOLTAGE	120-277v
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	11-1/16" x 6-1/8" x 6-1/8"
FINISH	Black
RATING	IP
LISTING	

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000k
CRI	80+
LUMEN OUTPUT	2000
ANTICIPATED LIFE	60000

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES

Pendant mount fixed cylinder with one (1) LED lighting source, 2000 delivered lumens, 3000k color engine, 80+ CRI. Cylinder should operate on 120-277v voltage with a 60000 hour anticipated life. Cylinder to have black finish.

CONTROL

PROTOCOL	
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

C72

LITHONIA LIGHTING®

Catalog Number	LDN4CYL 30/20 L04 AR LSS MVOLT EZ1 ACC DBL
Notes	
Type	

LDN4CYL

4" CYLINDER
Non-IC

FEATURES & SPECIFICATIONS

INTENDED USE — Typical applications include corridors, lobbies, conference rooms and private offices.

CONSTRUCTION — Heavy-gauge aluminum housing.

Ceiling mount for direct installation to 4" octagonal or square junction box.

Pendant mount entry for 3/8" National Pipe Thread stem; wires supplied by others.

Textured polyester powder paint finish standard.

Multiple ceiling, pendant, cord, and wall mount options available.

OPTICS — LEDs are binned to a 3-step SDCM; 80 CRI minimum. 90 CRI optional.

LED light source concealed with diffusing optical lens.

General illumination lighting with 1.0 S/MH and 55° cutoff to source and source image.

Self-flanged anodized reflectors in specular, semi-specular, or matte diffuse finishes. Also available in white and black painted reflectors.

ELECTRICAL — Multi-volt (120-277V, 50/60Hz) 0-10V dimming drivers mounted to junction box, 10% or 1% minimum dimming level available.

347V available option; transformer must be field-installed to an accessible remote-mounted junction box.

0-10V dimming fixture requires two (2) additional low-voltage wires to be pulled.

70% lumen maintenance at 60,000 hours.

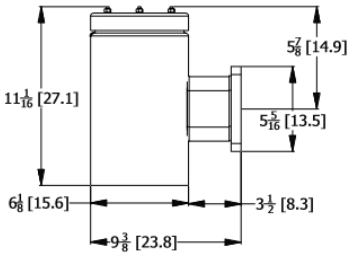
LISTINGS — Certified to US and Canadian safety standards. Damp location standard (wet location, covered ceiling optional).

GOVERNEMENT PROCUREMENT — BAA – Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

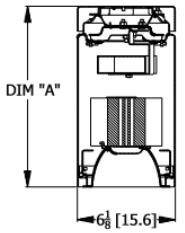
WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

* All dimensions are inches (centimeters) unless otherwise noted.



LDN4 CYLINDER WALL MOUNT



LDN4 CYLINDER

LDN4CYL 3500K AR LSS 80CRI			
Nominal	**Lumens**	**Wattage**	**Lm/W**
500	523.6	5.74	91.2
750	751.1	8.6	87.3
1000	1045	10.58	98.8
1500	1512	17.5	86.4
2000	2006	22.12	90.7
2500	2551	26.1	97.7
3000	3007	32.1	93.7
4000	4212	43	98.0

DIMENSION TABLE	
STYLE	**DIM "A"**
CEILING MOUNT (FCM)	10-13/16
CEILING MOUNT WET LOCATION (FCM WL)	10-13/16
PENDANT MOUNT (PM)	10
PENDANT MOUNT WET LOCATION (PM WL)	11
CABLE MOUNT (ACC)	9-13/16

LDN4CYL

Design Select options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example:** LDN4CYL 35/15 LO4AR LSS MVOLT EZ1 FCM DWHG

LDN4CYL

Series	Color temperature	Lumens	Aperture/Trim Color		Finish	Voltage
LDN4CYL 4" cylinder	27/ 2700K	05 500 lumens	LO4 Downlight	AR Clear	LSS Semi-specular	MVOLT Multi-volt
	30/ 3000K	07 750 lumens	LW4[1] Wallwash	WR ‡ White	LD Matte diffuse	120 120V
	35/ 3500K	10 1000 lumens		BR ‡ Black	LS Specular	277 277V
	40/ 4000K	15 1500 lumens				
	50/ 5000K	20 2000 lumens				

Driver[3]	Mounting	Options	Architectural Colors ‡
GZ10 0-10V driver dims to 10%	FCM Ceiling mount	SF[6] Single fuse	DWHG Matte white (standard)
GZ1 0-10V driver dims to 1%	WM Wall mount	90CRI High CRI (90+)	DDB Dark bronze
EZ1 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1%	PM ‡ Pendant 3/8" thread mount	WL ‡ Wet location	DBL Black
	ACC ‡ 10ft aircraft cable and cord mount	nLight Options:	DWH Glossy white
	ACC180 ‡ 15ft aircraft cable and cord mount	NPP16D ‡ nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).	DMB Medium bronze
		NPP16DER ‡ nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.	DNA Natural aluminum
		NPS80EZ ‡ nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1).	DSS Sandstone
		NPS80EZER ‡ nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1). ER controls fixtures on emergency circuit.	DGC Charcoal grey
			DTG Tennis green
			DBR Bright red
			DSB Steel blue

Accessories: *Order as separate catalog number. (shipped separately)*

CYS ‡	3/8" stem and canopy with 5" "hang straight" swivel
CRS ‡	3/8" stem and canopy with 45° swivel
SDT 347/120 75VA12 ‡	347V Step-down transformer

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

(Maximum order quantity for design select lead times is 50)

‡ Option Value Ordering Restrictions

Option value	Restriction
LW4	Not available in ACC mount.
WR, BR	Not available with finishes.
PM	Supplied with 10" supply and dimming connections.
ACC, ACC180	White cord supplied with white housings. All other finishes supplied with black cord.
SF	Must specify voltage 120V or 277V.
NPP16D, NPP16DER, NPS80EZ, NPS80EZER	Specify voltage. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed. Interface remote mounted. Access panel (supplied by others) recommended. See UL 924 Sequence of Operation table.
WL	Not available with ACC & ACC180 mounting options.
Architectural Colors	Additional architectural colors available; see www.lithonia.com/archcolors.
CYS, CRS	Color and length of stem must be specified (from 6" to 240" in even increments in maximum sections of 48"). Ex.: CYS06 DWHG. Ceiling attachment for interior use. Consult factory for exterior use.
SDT 347/120 75VA	Must be field-installed to an accessible remote-mounted junction box

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

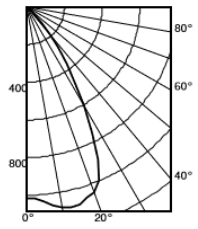
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 04/11/25

LDN4CYL

PHOTOMETRY

Distribution Curve | **Distribution Data** | **Output Data** | **Coefficient of Utilization** | **Illuminance Data at 30" Above Floor for a Single Luminaire**

LDN4 35/10 LO4AR, input watts: 10.58, delivered lumens: 1085.2, LM/W = 102.57, spacing criterion at 0= 1.04, test no. ISF 30712P424.



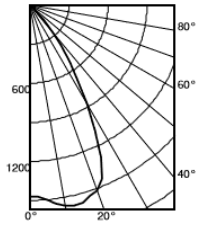
	Ave	Lumens
0	1017	
5	1039	101
15	1084	304
25	895	395
35	369	232
45	52	51
55	1	2
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	799.7	73.7
0° - 40°	1031.5	95.1
0° - 60°	1084.7	100.0
0° - 90°	1085.2	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	1085.2	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	50% 50%	50% 30%	50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	79	73	69	79	73	69	77	72	68
7	75	69	64	74	68	64	73	68	64
8	70	64	60	70	64	60	69	63	60
9	66	60	56	66	60	56	65	60	56
10	63	57	53	62	57	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	33.6	5.8	16.8	8.9	3.4
10.0	18.1	7.9	9.0	12.2	1.8
12.0	11.3	10.0	5.6	15.4	1.1
14.0	7.7	12.1	3.8	18.6	0.8
16.0	5.6	14.2	2.8	21.9	0.6

LDN4 35/15 LO4AR, input watts: 17.5, delivered lumens: 1570.1, LM/W = 89.72, spacing criterion at 0= 1.04, test no. ISF 30712P429.



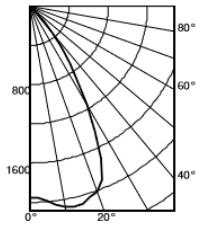
	Ave	Lumens
0	1472	
5	1503	146
15	1569	440
25	1295	571
35	534	335
45	75	74
55	1	3
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1157.1	73.7
0° - 40°	1492.5	95.1
0° - 60°	1569.4	100.0
0° - 90°	1570.1	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	1570.1	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	50% 50%	50% 30%	50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	79	73	69	79	73	69	77	72	68
7	75	69	64	74	68	64	73	68	64
8	70	64	60	70	64	60	69	63	60
9	66	60	56	66	60	56	65	60	56
10	63	57	53	62	57	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	48.7	5.8	24.3	8.9	4.9
10.0	26.2	7.9	13.1	12.2	2.6
12.0	16.3	10.0	8.2	15.4	1.6
14.0	11.1	12.1	5.6	18.6	1.1
16.0	8.1	14.2	4.0	21.9	0.8

LDN4 35/20 LO4AR, input watts: 22.12, delivered lumens: 2083.1, LM/W = 94.17, spacing criterion at 0= 1.04, test no. ISF 30712P434.



	Ave	Lumens
0	1952	
5	1994	193
15	2081	584
25	1718	758
35	709	445
45	99	98
55	2	4
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1535.2	73.7
0° - 40°	1980.1	95.1
0° - 60°	2082.1	100.0
0° - 90°	2083.1	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	2083.1	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	50% 50%	50% 30%	50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	79	73	69	79	73	69	77	72	68
7	75	69	64	74	68	64	73	68	64
8	70	64	60	70	64	60	69	63	60
9	66	60	56	66	60	56	65	60	56
10	63	57	53	62	57	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	64.5	5.8	32.3	8.9	6.5
10.0	34.7	7.9	17.4	12.2	3.5
12.0	21.6	10.0	10.8	15.4	2.2
14.0	14.8	12.1	7.4	18.6	1.5
16.0	10.7	14.2	5.4	21.9	1.1

LUMEN OUTPUT MULTIPLIERS - FINISH			
	Clear (AR)	White (WR)	Black (BR)
Specular (LS)	1.0	N/A	N/A
Semi-specular (LSS)	0.950	N/A	N/A
Matte diffuse (LD)	0.85	N/A	N/A
Painted	N/A	0.87	0.73

LUMEN OUTPUT MULTIPLIERS - CCT					
	2700K	3000K	3500K	4000K	5000K
80CRI	0.950	0.966	1.000	1.025	1.101

LUMEN OUTPUT MULTIPLIERS - CRI	
80	1.0
90	0.874

Notes

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 80 typical.

LITHONIA LIGHTING®

LDN4CYL

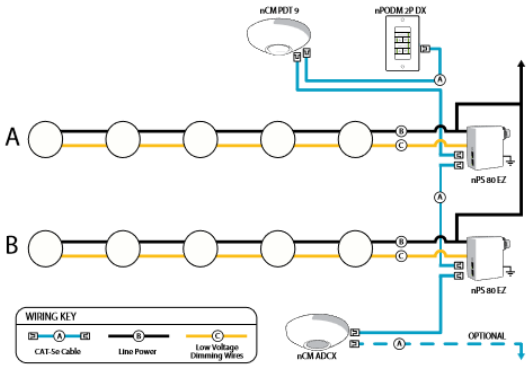
DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 04/11/25

LDN4CYL

ADDITIONAL DATA

COMPATIBLE 0-10V WALL-MOUNT DIMMERS		
MANUFACTURER	PART NO.	POWER BOOSTER AVAILABLE
Lutron®	Diva® DVTV	
	Diva® DVSCTV	
	Nova T® NTFTV	
	Nova® NFTV	
Leviton®	AWSMT-7DW	CN100
	AWSMG-7DW	PE300
	AMRMG-7DW	
	Leviton Centura Fluorescent Control System	
	IllumaTech® IP7 Series	
Synergy®	ISD BC	RDMFC
	SLD LPCS	
	Digital Equinox (DEQ BC)	
Douglas Lighting Controls	WPC-5721	
Entertainment Technology	Tap Glide TG600FAM120 (120V)	
	Tap Glide Heatsink TGH1500FAM120 (120V)	
	Oasis OA2000FAMU	
Honeywell	EL7315A1019	EL7305A1010 (optional)
	EL7315A1009	
HUNT Dimming	Preset slide: PS-010-IV and PS-010-WH	
	Preset slide: PS-010-3W-IV and PS-010-3W-WH	
	Preset slide, controls FD-010: PS-IFC-010-IV and PS-IFC-010-WH-120/277V	
	Preset slide, controls FD-010: PS-IFC-010-3W-IV and PS-IFC-010-3W-WH-120/277V	
	Remote mounted unit: FD-010	
Lehigh Electronic Products	Solitaire	PBX
PDM Electrical Products	WPC-5721	
Starfield Controls	TR61 with DALI interface port	RT03 DALInet Router
WattStopper®	LS-4 used with LCD-101 and LCD-103	



nLight® Control Accessories:
Order as separate catalog number.
Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	Model number
On/Off	nPODM [color]
On/Off & Raise/Lower	nPODM DX [color]
Graphic Touchscreen	nPOD GFX [color]
Photocell controls	**Model number**
Dimming	nCM ADCX

Occupancy sensors	Model number
Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Wide view (PIR / dual tech)	nWV 16 / nWV PDT 16
Wall Switch w/ Raise/Lower (PIR / dual tech)	nWSX LV DX / nWSX PDT LV DX
Cat-5 cables (plenum rated)	**Model number**
10', CAT5 10FT	CAT5 10FT J1
15', CAT5 15FT	CAT5 15FT J1

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 04/11/25

EQUIPMENT

MANUFACTURER	HomeLava
CATALOG NUMBER	Black Crystal Chandelier Luxury Modern Black Ceiling Lighting Fixture 8 Lights #9999P4970
TOTAL WATTS	9
VOLTAGE	120
MOUNTING	Pendant
WEIGHT	
DIMENSIONS	5" x 5" x 7.6"
FINISH	Aged Brass; Black cord
RATING	IP
LISTING	UL Dry Listed

SOURCE

MANUFACTURER	Bulbrite
CATALOG NUMBER	776200
QUANTITY	8
CCT	2700k
CRI	80+
LUMEN OUTPUT	400
ANTICIPATED LIFE	15000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Decorative Pendant mount fixed light with eight (8) LED lighting sources each, 400 delivered lumens, 2700k color engine, 80+ CRI and integral driver. Light should operate on 120 voltage and be supplied with a line voltage dimmer control option with a 15000 hour anticipated life. Light to have aged brass; black cord finish. Light should be UL listed for dry use or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

New Customer Coupon Code : NEWHOME

C91
HomeLava Black Crystal Chandelier Luxury Modern Black Ceiling Lighting Fixture 8 Lights #9999P4970

Black Crystal Chandelier Luxury Modern Black Ceiling Lighting Fixture 8 Lights

USD $309.99

(1)

Voltage:

110-120V

8Pcs 3W LED Bulbs:

No"thanks

Estimated Shipping Date: **7-11** Weekdays
Shipping Time Excluded

Quantity: 1 Buy 5+ and Save

ADD TO CART

Description

Key Features

1. Features:Crystal
2. Chain/Cord Adjustable or Not:Chain/Cord Adjustable

Specifications

Light Information	
Type	Chandeliers
Features	**Crystal**
Style	Modern/Contemporary
Finish	Electroplated
Number of Tiers	1 Tier
Light Direction	Uplight
Suggested Room Fit	Kitchen,Dining Room,Living Room
Suggested Room Size	50-60㎡
Dimensions	
Fixture Height	50 cm (20 inch)
Fixture Width	70 cm (28 inch)
Fixture Length	70 cm (28 inch)
Chain/Cord Length	Max 50 cm (20 inch)
Chain/Cord Adjustable or Not	**Chain/Cord Adjustable**
Bulb Information	
Number of Bulbs	8
Bulb Base	E12/E14
Wattage per Bulb	Max 40W
Bulb Included or Not	Bulb Not Included (If you purchase the matching light bulb, warm white bulbs will be emitted by default.)
Material	
Fixture Material	Glass
Shade Material	Fabric
Decoration Material	Crystal
Color	
Fixture Color	Black
Shade Color	Black
Decoration Color	Black
Weights	
Net Weight(kg)	7

EQUIPMENT

MANUFACTURER	Aculux
CATALOG NUMBER	AX4 D 27 LM 30K 90CRI 40D EZB MVOLT 4DP CS SF
TOTAL WATTS	25
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	11" x 8.1" x 4.5"
FINISH	Clear Anodized
RATING	IP
LISTING	Energy Star

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	30k
CRI	90+
LUMEN OUTPUT	2737
ANTICIPATED LIFE	50000

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES

Recessed mount fixed downlight with one (1) LED lighting source, 2737 delivered lumens, 30k color engine, 90+ CRI, 40° optic. Downlight should operate on 120-277 voltage and be supplied with a 0-10v control option down to 0.1% and include a minimum 5-year warranty with a 50000 hour anticipated life. Downlight to have clear anodized finish. Downlight should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

D55
AX4 D 27LM 30K 90CRI 40D EZB
MVOLT 4DP CS SF

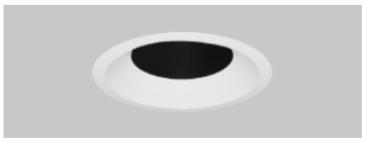
ACULUX®

AX4 SERIES | 4" APERTURE

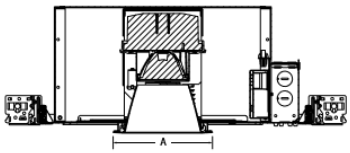
Downlight | 1200 – 3200 Lumens

TRIM STYLES

Reflector



Bevel



A Dimension:
Self Flanged: 5.7"
Flangeless: 4.9"

FEATURES

SPOT ON! OPTICS

- 45° Visual cutoff to source and source image
- Field Interchangeable TIR Optics in 11 distributions including a Wide Batwing distribution for general illumination
- Accommodates up to 2 beam control lenses or filters

TRU-LINE™ PRECISION INSTALLATION

- Patented aperture translation features +/- ½" of translation ensures perfect fixture-to-fixture alignment (US Patent 8,277,090)
- Robust Pro-VI™ bar hangers provide robust, non-binding action. (US Patent 8,038,113)

EXCEPTIONAL PERFORMANCE FROM 4-INCH APERTURE

- Up to 3258 lumens delivered!
- Exceptionally consistent color with < 2SDCM for Static White & Tunable White; <1SDCM for WarmDim
- Excellent color rendition with 95+ CRI | 90+ R9 Available
- WarmDim® option mimics halogen dimming (3000K-1800K)
- Tunable White CCT range of 5000K –2700K

PERFORMANCE

LUMEN PACKAGE	WATTS IN	DELIVERED LUMENS	EFFICACY (LPW)
Static White*			
12LM	9	1271	141
17LM	13	1629	125
22LM	19	2216	116
27LM	25	2737	109
32LM	33	3258	98
WarmDim®			
08LM	16	743	46
12LM	26	1209	47
15LM	29	1475	51
17LM	33	1636	50
Tunable White			
12LM	19	1346	71
17LM	28	1972	70
22LM	38	2514	66

*Performance with 4DP trim at 30K | 80CRI (Static White), 30K | 90CRI (WarmDim) & 50K | 90CRI (Tunable White)
Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25°C

FLANGE STYLES

Self-Flanged

Flangeless (Gypsum)

Flangeless (Wood | Stone | Tile)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

D55
AX4 D 27LM 30K 90CRI 40D EZB
MVOLT 4DP CS SF

ACULUX

AX4 SERIES | 4" APERTURE

Downlight | 1200 – 3200 Lumens

ORDERING INFORMATION

EXAMPLE: AX4 D 27LM 30K 95CRI 24D FPC 120 ICAT 4DBV BD WHSF

Housing Style	Lumens	CCT	CRI	Beam	Driver	Voltage[4]	Ratings	Options
AX4 D New Construction Fixed Downlight	**Static White** 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens 27LM 2700 lumens 32LM[1] 3200 lumens	27K 2700K 30K 3000K 35K[2] 3500K 40K[2] 4000K	80CRI 90CRI 95CRI	12D 12° beam 20D 20° beam 24D 24° beam 30D 30° beam 35D 35° beam 40D 40° beam 45D 45° beam 50D 50° beam 55D 55° beam 50D20D 50°x 20° WD Wide (1.1 S/MH)	GZ1 0-10V	1% min EZ1 0-10V eldoLED	linear 1% min EZB 0-10V eldoLED	log <1% min EDXB eldoLED DMX	square <1% min EDAB eldoLED DALI 6	log <1% min FPC Phase Cut Dimming	1% min ECOD Lutron EcoSystem	1% min	120 277 MVOLT (120-277)	(blank) Non-ICAT CP[5] Chicago Plenum ICAT[5] IC Rated, Air-tight	NLIGHT[6] nLight Dimming pack controls (Static White and WarmDim only) E6WT20R[7] Emergency 6W battery pack with remote test switch, T20 compliant
	WarmDim® 08LM 800 lumens 12LM 1200 lumens 15LM 1500 lumens 17LM 1700 lumens	WDIM HALR 3000K - 1800K	90CRI	10D[3] 10° beam 15D[3] 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50°x 20° WD Wide (1.1 S/MH)	GZ1 0-10V	1% min FPC Phase Cut Dimming	1% min					
	Tunable White 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens	TUWH 5000K - 2700K	90CRI	15D 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50°x 20° WD Wide (1.1 S/MH)	GZ1 0-10V	1% min EZ1 eldoLED 0-10V	linear 1% min EZB eldoLED 0-10V	log <1% min NLT[6] nLight nTune interface EDAB eldoLED DALI 6	log <1% min EDABT8 eldoLED DALI 8	log <1% min			

Trim	Reflector Finish	Flange Style	Trim Lens | Environment
Downlight Reflector 4DP Deep Downlight Cone	W White Paint CD Clear Diffuse CS Clear Specular BS Black Specular WTD Wheat Diffuse	*Flanged* SF Self Flanged WHSF Self Flanged, White Painted Flange (not available with W finish) *Flangeless*[8] FM Flangeless	(blank) Open | Damp Location WET Solite | Wet Location
Bevel 4DBV BD Downlight Bevel	**Bevel Finish & Flange Style** *Flanged* WHSF White, Flanged BLSF Black, Flanged *Flangeless*[8] WHFM White, Flangeless BLFM Black, Flangeless		(blank) Open | Damp WET Solite | Wet Location

Ceiling Installation

Flanged
(blank) Ceiling Thickness < 0.875"
CTA4/125 Ceiling Thickness 0.875" - 1.25"
CTA4/163 Ceiling Thickness 1.25" - 1.625"
CTA4/200 Ceiling Thickness 1.625" - 2"

Flangeless (Gypsum)
FMA4/087 Ceiling Thickness < 0.875"
FMA4/125 Ceiling Thickness 0.875" - 1.25"
FMA4/163 Ceiling Thickness 1.25" - 1.625"
FMA4/200 Ceiling Thickness 1.625" - 2"

Flangeless (Wood | Stone | Tile)[9]
SFM4/087 (B,W) Ceiling Thickness < 0.875"
SFM4/125 (B,W) Ceiling Thickness 0.875" - 1.25"
SFM4/163 (B,W) Ceiling Thickness 1.25" - 1.625"

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

REFLECTOR FINISHES

BEVEL FINISHES

ORDERING NOTES

1. 32LM not available with ICAT and CP.
2. 95CRI available on 27K and 30K only. Contact factory for other CCT/CRI combinations.
3. For WDIM, 10D only available with 08LM and 12LM; 15D only available with 15LM and 17LM.
4. MVOLT standard on GZ1, EZ1, EZB, ECOD, EDXB, EDAB, EDABT8, NLT (unless NLIGHT). Must be 120 for FPC.
5. CP or ICAT not available with 17LM WDIM or 22LM TUWH
6. Must specify 120 or 277 volts for NLIGHT; MVOLT for NLT. NLIGHT only available with EZ1, EZB (for static white) or GZ1 (for warmDim). NLT not available with CP.
7. E6WT20R not available with WDIM, TUWH, EDXB, CP, ICAT, or NLIGHT.
8. Must specify FMA4 or SFM4 option.
9. Specify finish: B = Black, W = White.

ACCESSORIES

Beam Control Lenses & Filters

DIFF 300	Diffuse Spread lens
SOLITE 300	Solite Uniformity Lens
PRISM 300	Prismatic Lens
LSPREAD 300	Linear Spread Lens
HCLBL 300	Hexcell Louver
UVF 300	UV Filter Lens
DCCF 300 HAL4250	Daylight Blue Correction

Replacement Optics

Static White Optics

4AXOPT/12D	12° Beam
4AXOPT/20D	20° Beam
4AXOPT/24D	24° Beam
4AXOPT/30D	30° Beam
4AXOPT/35D	35° Beam
4AXOPT/40D	40° Beam
4AXOPT/45D	45° Beam
4AXOPT/50D	50° Beam
4AXOPT/55D	55° Beam
4AXOPT/50D20D	50°x20° Beam
4AXOPT/WD	Wide (1.1 S/MH)

WarmDim Optics

4AXWDOPT/10D	10° Beam
4AXWDOPT/15D	15° Beam
4AXWDOPT/20D	20° Beam
4AXWDOPT/24D	24° Beam
4AXWDOPT/35D	35° Beam
4AXWDOPT/45D	45° Beam
4AXWDOPT/55D	55° Beam
4AXWDOPT/50D20D	50°x20° Beam
4AXWDOPT/WD	Wide (1.1 S/MH)

Tunable White Optics

4AXTWOPT/15D	15° Beam
4AXTWOPT/20D	20° Beam
4AXTWOPT/24D	24° Beam
4AXTWOPT/35D	35° Beam
4AXTWOPT/45D	45° Beam
4AXTWOPT/55D	55° Beam
4AXTWOPT/50D20D	50°x20° Beam
4AXTWOPT/WD	Wide (1.1 S/MH)

Optional Installation Accessories

Bar Hangers

HB1	Juno Real Nail® 3 Bar Hangers
HB26	26" C-Channel Bar Hangers
HB50	50" C-Channel Bar Hangers
LB27	27" Linear Bar Hangers

Note: Fixture supplied with Pro-Vi™ Bar Hangers

Emergency Inverter

IIS 35 HE	Up to 35W Remote Mount Micro Inverter (30LM Excluded)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PRODUCT SPECIFICATIONS

FIELD INTERCHANGEABLE LED LIGHT ENGINE

- Future proof and easy to maintain-serviceable from below the ceiling

Static White:

- <2SDCMBinning
- 2700K|3000K|3500K|4000K CCT
- 80 & 90CRI available for all CCTs
- 95+ CRI (>90 R9) available for 2700K, 3000K

WarmDim:

- Proprietary WarmDim technology mimics halogen,with CCT shifting from 3000K to 1800K when dimmed.
- <1SDCM Binning, 90+CRI

Tunable White:

- Tunable CCT range 5000K to 2700K
- <2 SDCM Binning, 90+ CRI

SPOT-ON! PRECISION OPTICS

- 45° Visual cutoff to source and source image
- Field Interchangeable TIR Optics delivering high centerbeam downlighting in 12° FWHM to 55° FWHM.
- Available with a wide batwing distribution for general illumination with up to 1.1 S/MH ratio.
- Patented self-adjusting optic holder accommodates up to 2 beam control lenses or filters (US Patent 8,950,911).
- UGR is zero for fixtures aimed at nadir with a cut-off equal to or less than 60°, per CIE 117-1996 Discomfort Glare in Interior Lighting. UGR FAQs

HIGH QUALITY TRIMS

- Available with die cast bevels and spun aluminum reflectors.
- Available in Self Flanged and Flangeless
- Must Specify FMA4 for gypsum flangeless installation
- Must specify SFM4 for wood, stone, tile flangeless installation

FIELD REPLACEABLE DRIVER

- Accommodates 120-277V input and multiple control protocols down
- Dims without perceived flicker to <1% depending on driver specified
- Field replaceable without tools from below the ceiling
- >0.9 Power Factor

BUY AMERICAN ACT

- This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
- Please refer to www.acuitybrands.com/resources/buy-american for additional information.

WARRANTY & RATED LIFE

- LED is rated for >50,000 hours at 70% lumen maintenance
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

EMERGENCY BATTERY

- Provides a minimum of 700 lumens (4DP, 3000K, 80CRI) for minimum duration of 90 minutes.
- Accessible below ceiling for simple service; Self-Testing
- Supplied with Class-2 plenum rated remote test switch
- CEC T20 Compliant

NEW CONSTRUCTION MOUNTING

- Features patented (US Patent 8,038,113) Pro-Vl™ bar hanger system offering compatible with wood stud and T-bar
- All fixtures also feature vertically adjustable mounting brackets (butterfly brackets)
- Centerline indicators on plaster frame and patented (US Patent 8,277,090) Tru-Line™ Platform featuring +/- ½" translation aids fixture alignment after installation, prior to finishing the ceiling.

JUNCTION BOX

- Rated for (4) No. 12 AWG 90°C through branch circuit conductors.
- Includes (6) ½", (1) ¾", (4) Non-metallic sheathed cable knock-outs.
- Push-in electrical connectors for field connections.

CODES & LABELS

- UL & cUL listed for through branch wiring, damp location
- Meets energy code Air Leakage requirements per ASTM E283
- ENERGY STAR® certified with select trims and housings
- Can be used to comply with Title 24, Part 6 with select trims and housings. Reference T24 JA-8 database for list of compliant housings and trims.
- ICAT Static White housings are rated for direct contact with insulation, including open and closed cell spray foam* with a maximum R-value of 7.2R/in. This allows use in ceiling cavities insulated up to R60.
- ICAT WarmDim and Tunable White housings are rated for direct contact with insulation, including open cell spray foam* with a maximum R-value of 3.8R/in. They are not suitable for use with closed cell spray foam. *Note: Options: "12LM WDIM", "ECOD", "EDXB", "NLT" & "NLIGHT" are excluded and not suitable for use with spray foam insulation.
- Union made

CEILING THICKNESS

- Accommodates ½" to 2" ceiling thickness

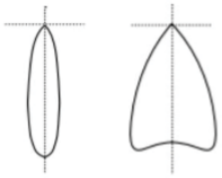
A+ CAPABLE LUMINAIRE

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning, when used with Acuity Brands controls products.

- All configurations of this luminaire are calibrated and tested to meet the Acuity Brand's specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

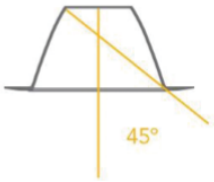
To learn more about Acuity A+ standards, specifications and testing, visit www.acuitybrands.com/aplus.

Spot On! Precision Optics



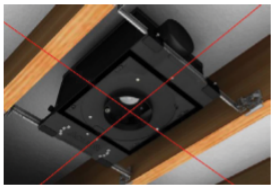
Smooth striation-free beam with high centerbeam or wide batwing distribution for general illumination

Exceptional Brightness and Glare Control



45-degree visual cutoff to source and source image

Tru-Line™ Precision Installation

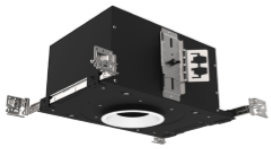


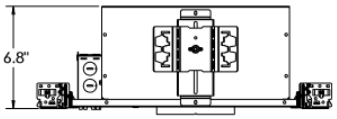
Pro-Vl™ bar hangers, coupled with +/-1/2" aperture translation makes perfect installation achievable

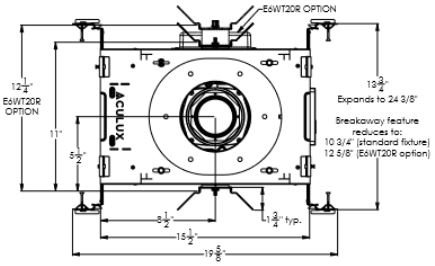
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMENSIONS

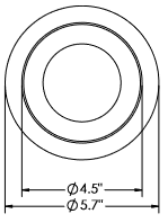
New Construction Downlight (AX4 D)
ICAT/Non-ICAT: 12LM | 17LM | 22LM | 27LM
Non-ICAT: 32LM
Ceiling Cutout: 5-1/4" (refer to installation instructions for flangeless ceiling cutout)



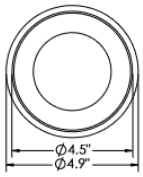




Reflector Trim (4DP)

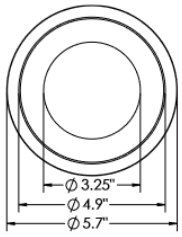


Flanged

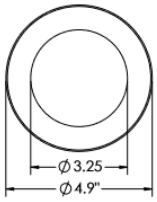


Flangeless

Bevel Trim (4DBV)



Flanged



Flangeless

ELECTRICAL SPECIFICATIONS

Static White

LUMEN PACKAGE	12LM		17LM		22LM		27LM		32LM	
Voltage	120	277	120	277	120	277	120	277	120	277
Input Watts	9.5	10.0	13.7	14.7	19.5	20.4	25.8	26.4	33.4	33.6
Input Current	0.08	0.04	0.11	0.06	0.16	0.08	0.22	0.10	0.28	0.13
Frequency	50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
Power Factor	0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

WarmDim

08LM		12LM		15LM		17LM	
120	277	120	277	120	277	120	277
16.1	16.5	25.6	25.9	28.9	29.0	32.8	32.9
0.14	0.06	0.21	0.10	0.24	0.11	0.27	0.12
50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

Tunable White

12LM		15LM		22LM	
120	277	120	277	120	277
18.2	19.5	27.2	28.0	36.9	37.5
0.15	0.08	0.23	0.11	0.31	0.14
50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.	

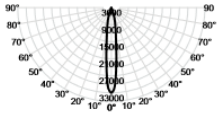
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PHOTOMETRICS - 4DP

Tested in accordance to IESNA LM79

12 Degree Beam

AX4 D 32LM 30K 80CRI 12D EZ1 MVOLT 4DP CS Input Watts: 33.4, Delivered Lumens: 3290, LPW: 98.5, S/MH: 0.23, Test No: 20-421-01P198



CP Summary

	0°
0°	30,067
5°	20,001
15°	4,618
25°	620
35°	98
45°	29
55°	6
65°	2
75°	1
85°	0
90°	0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	3,189	97%
0° - 40°	3,259	99%
0° - 60°	3,288	100%
0° - 90°	3,290	100%

Coefficients of Utilization

pf pc	80%			20%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	113	112	110	111	110	108	107	106	105
2	109	106	104	107	105	102	104	102	100
3	105	101	99	103	100	98	101	98	96
4	101	97	95	100	97	94	98	95	93
5	98	94	91	97	94	91	96	93	90
6	95	91	89	94	91	88	93	90	88
7	93	89	86	92	88	86	91	88	86
8	90	87	84	90	86	84	89	86	84
9	88	84	82	88	84	82	87	84	82
10	86	83	80	86	82	80	85	82	80

Cone of Light

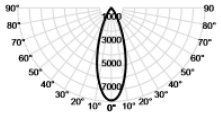
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	835.2	1.4
8.0	469.8	1.9
10.0	300.7	2.4
12.0	208.8	2.8
14.0	153.4	3.3

Luminance (cd/sq.m)

	Average Luminance
45°	3,946
55°	930
65°	437
75°	238
85°	118

35 Degree Beam

AX4 D 32LM 30K 80CRI 35D EZ1 MVOLT 4DP CS Input Watts: 33.4, Delivered Lumens: 3229, LPW: 96.7, S/MH: 0.56, Test No: 20-421-05P198



CP Summary

	0°
0°	7,898
5°	7,462
15°	4,738
25°	1,874
35°	505
45°	38
55°	7
65°	3
75°	1
85°	0
90°	0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	2,837	88%
0° - 40°	3,167	98%
0° - 60°	3,225	100%
0° - 90°	3,229	100%

Coefficients of Utilization

pf pc	80%			20%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	112	110	108	110	108	106	106	104	103
2	106	102	99	104	101	98	101	98	96
3	100	96	93	99	95	92	96	93	90
4	95	91	87	94	90	86	92	88	85
5	91	86	82	90	85	82	88	84	81
6	86	81	78	86	81	78	84	80	77
7	83	78	74	82	77	74	81	77	74
8	79	74	71	79	74	71	78	73	70
9	76	71	68	75	71	68	75	70	67
10	73	68	65	72	68	65	72	68	65

Cone of Light

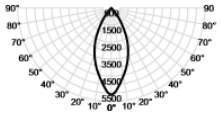
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	219.4	3.8
8.0	123.4	5.0
10.0	79.0	6.3
12.0	54.8	7.5
14.0	40.3	8.8

Luminance (cd/sq.m)

	Average Luminance
45°	5,048
55°	1,234
65°	582
75°	317
85°	235

50 Degree Beam

AX4 D 32LM 30K 80CRI 50D EZ1 MVOLT 4DP CS Input Watts: 33.4, Delivered Lumens: 3036, LPW: 90.9, S/MH: 0.68, Test No: 20-421-08P198



CP Summary

	0°
0°	5,092
5°	4,663
15°	3,491
25°	2,250
35°	912
45°	49
55°	10
65°	4
75°	1
85°	0
90°	0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	2,408	79%
0° - 40°	2,960	97%
0° - 60°	3,031	100%
0° - 90°	3,036	100%

Coefficients of Utilization

pf pc	80%			20%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	109	107	109	107	105	105	104	102
2	104	101	97	103	99	96	99	97	94
3	98	93	90	97	92	89	94	90	88
4	92	87	83	91	86	83	89	85	82
5	87	82	78	86	81	77	84	80	77
6	82	77	73	81	76	72	80	75	72
7	78	72	68	77	72	68	76	71	68
8	74	68	64	73	68	64	72	67	64
9	70	65	61	70	64	61	69	64	61
10	67	61	58	66	61	58	66	61	58

Cone of Light

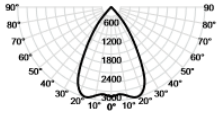
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	141.4	5.0
8.0	79.6	6.7
10.0	50.9	8.4
12.0	35.4	10.0
14.0	26.0	11.7

Luminance (cd/sq.m)

	Average Luminance
45°	6,527
55°	1,699
65°	849
75°	476
85°	353

WD Beam

AX4 D 32LM 30K 80CRI WD EZ1 MVOLT 4DP CS Input Watts: 33.4, Delivered Lumens: 2801, LPW: 83.9, S/MH: 1.05, Test No: 20-421-11P198



CP Summary

	0°
0°	2,857
5°	2,801
15°	2,987
25°	2,517
35°	1,074
45°	94
55°	19
65°	7
75°	2
85°	0
90°	0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	2,056	73%
0° - 40°	2,656	95%
0° - 60°	2,791	100%
0° - 90°	2,801	100%

Coefficients of Utilization

pf pc	80%			20%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	117	117	117	111	111	111
1	111	109	107	109	107	105	105	103	102
2	104	100	96	102	98	95	99	96	93
3	97	92	88	95	91	87	93	89	86
4	90	85	81	89	84	80	87	83	79
5	85	79	75	84	78	74	82	77	74
6	80	74	69	79	73	69	77	72	69
7	75	69	65	74	69	65	73	68	64
8	71	65	61	70	64	60	69	64	60
9	67	61	57	66	60	57	65	60	56
10	63	57	53	63	57	53	62	57	53

Cone of Light

Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	79.4	7.4
8.0	44.6	9.9
10.0	28.6	12.4
12.0	19.8	14.9
14.0	14.6	17.4

Luminance (cd/sq.m)

	Average Luminance
45°	12,591
55°	3,129
65°	1,480
75°	793
85°	471

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

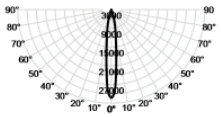
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PHOTOMETRICS - 4DBV

Tested in accordance to IESNA LM79

12 Degree Beam

AX4 D 32LM 30K 80CRI 12D EZ1 MVOLT 4DBV BD Input Watts: 33.4, Delivered Lumens: 2645, LPW: 79.2, S/MH: 0.22, Test No: 20-421-12P40



CP Summary

0°
28,265
17,955
3,699
371
47
15
2
1
0
0
0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	2,596	98%
0° - 40°	2,630	99%
0° - 60°	2,644	100%
0° - 90°	2,645	100%

Coefficients of Utilization

pf pc	80% pw	50%	30%	10%	20% 50%	70% 30%	10%	50% 50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	114	112	110	112	110	109	108	106	105
2	109	107	104	108	105	103	105	103	101
3	106	102	100	104	101	99	102	100	98
4	102	99	96	101	98	96	99	97	95
5	99	96	93	99	95	93	97	94	92
6	97	93	91	96	93	91	95	92	90
7	95	91	89	94	91	89	93	90	88
8	93	89	87	92	89	87	91	88	86
9	91	87	85	90	87	85	90	87	85
10	89	86	83	89	86	83	88	85	83

Cone of Light

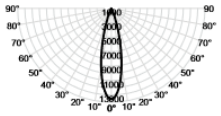
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	785.1	1.4
8.0	441.6	1.8
10.0	282.6	2.3
12.0	196.3	2.7
14.0	144.2	3.2

Luminance (cd/sq.m)

	Average Luminance
45°	4,068
55°	666
65°	286
75°	155
85°	0

24 Degree Beam

AX4 D 32LM 30K 80CRI 24D EZ1 MVOLT 4DBV BD Input Watts: 33.4, Delivered Lumens: 2654, LPW: 79.5, S/MH: 0.42, Test No: 20-421-14P40



CP Summary

0°
12,580
11,268
4,445
737
123
19
2
1
0
0
0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	2,548	96%
0° - 40°	2,633	99%
0° - 60°	2,653	100%
0° - 90°	2,654	100%

Coefficients of Utilization

pf pc	80% pw	50%	30%	10%	20% 50%	70% 30%	10%	50% 50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	113	111	110	111	109	108	107	106	105
2	108	105	103	106	104	101	103	101	99
3	104	100	97	102	99	96	100	97	95
4	100	96	93	99	95	92	97	94	91
5	96	92	89	95	92	89	94	91	88
6	93	89	86	92	89	86	91	88	85
7	90	86	83	90	86	83	88	85	83
8	87	83	81	87	83	81	86	83	80
9	85	81	78	85	81	78	84	80	78
10	83	79	76	82	79	76	82	78	76

Cone of Light

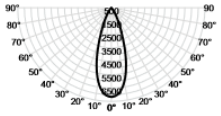
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	349.5	2.7
8.0	196.6	3.6
10.0	125.8	4.4
12.0	87.4	5.3
14.0	64.2	6.2

Luminance (cd/sq.m)

	Average Luminance
45°	4,978
55°	807
65°	286
75°	155
85°	0

35 Degree Beam

AX4 D 32LM 30K 80CRI 35D EZ1 MVOLT 4DBV BD Input Watts: 33.4, Delivered Lumens: 2716, LPW: 81.3, S/MH: 0.58, Test No: 20-421-16P40



CP Summary

0°
6,659
6,414
4,239
1,490
391
27
3
1
0
0
0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	2,422	89%
0° - 40°	2,676	99%
0° - 60°	2,715	100%
0° - 90°	2,716	100%

Coefficients of Utilization

pf pc	80% pw	50%	30%	10%	20% 50%	70% 30%	10%	50% 50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	112	110	108	110	108	106	106	105	103
2	106	103	100	104	101	99	101	99	97
3	101	96	93	99	95	92	97	94	91
4	96	91	88	95	90	87	93	89	86
5	91	86	83	90	86	83	89	85	82
6	87	82	79	86	82	79	85	81	78
7	83	79	75	83	78	75	82	78	75
8	80	75	72	79	75	72	78	74	71
9	77	72	69	76	72	69	76	71	68
10	74	69	66	74	69	66	73	69	66

Cone of Light

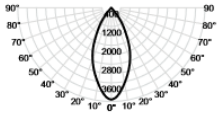
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	185.0	3.9
8.0	104.1	5.1
10.0	66.6	6.4
12.0	46.2	7.7
14.0	34.0	9.0

Luminance (cd/sq.m)

	Average Luminance
45°	7,169
55°	842
65°	333
75°	155
85°	0

50 Degree Beam

AX4 D 32LM 30K 80CRI 50D EZ1 MVOLT 4DBV BD Input Watts: 33.4, Delivered Lumens: 2428, LPW: 72.7, S/MH: 0.72, Test No: 20-421-19P40



CP Summary

0°
3,917
3,696
2,808
1,810
754
22
3
1
0
0
0

Zonal Lumen Summary

Zone	Lumens	% Fixture
0° - 30°	1,932	80%
0° - 40°	2,382	98%
0° - 60°	2,427	100%
0° - 90°	2,428	100%

Coefficients of Utilization

pf pc	80% pw	50%	30%	10%	20% 50%	70% 30%	10%	50% 50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	109	107	109	107	105	105	104	102
2	104	101	98	103	99	96	99	97	94
3	98	94	90	97	93	89	94	91	88
4	92	87	83	91	87	83	89	85	82
5	87	82	78	86	81	77	84	80	77
6	82	77	73	82	76	73	80	76	72
7	78	72	69	77	72	68	76	71	68
8	74	68	65	73	68	65	72	68	64
9	70	65	61	70	65	61	69	64	61
10	67	62	58	66	61	58	66	61	58

Cone of Light

Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	108.8	5.3
8.0	61.2	7.0
10.0	39.2	8.8
12.0	27.2	10.5
14.0	20.0	12.3

Luminance (cd/sq.m)

	Average Luminance
45°	5,803
55°	1,122
65°	428
75°	233
85°	231

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMMER COMPATIBILITY

Phase Dimming (FPC) - Incandescent, Magnetic Low Voltage and Electronic Low Voltage Dimming

- Dimming range of 100% down to as low as 1% a minimum load of one fixture
- Dimming range and maximum rated load vary depending on dimmer type and model. See maximum load calculations below to identify max number of luminaires per dimmer.

Incandescent (INC) and Magnetic Low Voltage (MLV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 50%
(600/13W) X 0.5 = 23 Fixtures per Dimmer

Electronic Low Voltage (ELV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 75%
(600/13W) X 0.75 = 34 Fixtures per Dimmer

INCANDESCENT, MLV, ELV WALL DIMMERS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	Glyder	GLV*	MLV	2
Leviton	SureSlide	6633*	INC	2
Lutron	Diva	DVLV	MLV	6
Lutron	Diva	DV*	INC	2
Lutron	Skylark	SLV*	MLV	3
Lutron	RadioRA 2	RRD-6D*	INC	2
Lutron	RadioRA 2	RRD-10ND*	INC	2
Leviton	SureSlide	6613	MLV	5
Leviton	IllumaTech	IPL06-10Z*	INC	3
Lutron	Diva	DVCL	INC	3
Insteon	Keypad Dimmer	2334-232	INC	2
Insteon	Dimmer Switch	2477D*	INC	2
Control4	Forward Phase Dimmer	C4-FPD 120	INC	2
Lutron	Nova	NTELV	ELV	6
Lutron	Diva	DVELV*	ELV	2
Lutron	Lutron Maestro	MAELV*	ELV	5
Leviton	Vizia	VPE06-1LX	ELV	2
Leviton	Illumatech	IPE04*	ELV	5
Lutron	Lutron RadioRA2	RRD-6NA	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2
Lutron	RadioRA2	RRD-6NA*	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Sensor Switch	WPD	WPD*	INC	1
Leviton	Illmatech	IPM06-1LZ	MLV	3
Leviton	Illmatech	IPI06-1LZ	INC	2
Lutron	Diva	DVCL	INC	1
Leviton	SureSlide	6633*	INC	1
Leviton	SureSlide	6613*	MLV	1
Leviton	SureSlide	IPL06	INC	1
Control4	Forward phase dimmer	C4-FPD 120 FWD*	INC	1
Lutron	Diva	DVELV*	ELV	1
Lutron	Maestro	MAELV*	ELV	1
Lutron	Vive	MRF25-6ELV*	ELV	1
Lutron	Caseta	PD-5NE*	ELV	1
Leviton	Illumatech	IPE04	ELV	4
Lutron	Maestro	RRD-PRO REV	PHA	1
Control4	Phase Adaptive Dimmer	C4-APD 120*	PHA	1
Lutron	Maestro	RRD-PRO FWD*	PHA	1

INTEGRATED CONTROL SYSTEMS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	LP	LP-RPM-4U	INC	5
Lutron	LP	LP-RPM-4A*	PHA	2
Lutron	GrafikEye QS	QSGRJ-3P	PHA	2
Lutron	GrafikEye QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	2
Acuity	nLight nSP5PCD ELV	nSP5PCD*	ELV	4
Insteon	Micro Module Dimmer	2442-222*	INC	2
Control4	8 Ch Dimmer	C4-DIN-8DIM-E	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Acuity	nLight nSP5PCD ELV	nSP5PCD ELV*	ELV	1
Acuity	nLight nSP5PCD ELV	PCDM*	ELV	1
Acuity	Fresco LMPM	LMPM 2D 2L*	PHA	1
Lutron	LP	LP-RPM-4A *	PHA	1
Lutron	LP	LP-RPM-4U*	INC	1
Lutron	GrafikEye QS	Lutron PHPM-PA-120*	PHA	1
Lutron	GrafikEye QS	Lutron Grafik Eye QSGRJ-3P*	MLV	1
Lutron	HomeWorks QS	PHPM-PA-120*	PHA	1
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	1
Legrand	Wattstopper	LMRC-221-U*	PHA	1
Control4	8 Ch Dimmer	C4-DIN-8DIM-E*	PHA	1
Crestron	Phase Adaptive Dimmer	6501748*	PHA	1

*: Aculux recommended dimmers

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

0-10V Dimming (GZ1, EZ1, EZB drivers)

WALL DIMMERS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	Diva	DVTV	0-10V	1	<1
Lutron	Nova	NFTV	0-10V	1	<1
Lutron	Nova T	NTFTV	0-10V	1	<1

INTEGRATED CONTROL SYSTEMS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	GrafikEye QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVM2*	0-10V	1	<1
Lutron	LCP128	GRX-TVI*	0-10V	1	<1
Lutron	LCP128	GRX-TVM2*	0-10V	1	<1
Lutron	LP	GRX-TVM2*	0-10V	1	<1
Lutron	RadioRA2	LMJ-5T-DV-B	0-10V	1**	<1
Crestron	GreenLight	DIN-4DIMFLV4	0-10V	1	<1
Lutron	Energi Tripak	RMJ-5T-DV-B	0-10V	1	<1
Wattstopper	DLM	LMRC-211	0-10V	1	<1
Insteon	Ballast Dimmer	2475DA2	0-10V	1	<1

*: Aculux recommended dimmers
**: Not tested with -GZ1
+: Requires a separate relay module to turn luminaire on/off

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Gotham
CATALOG NUMBER	IV04 D 25LM 30K 80CRI 45D DARK MVOLT EZT NCH P AR LS F
TOTAL WATTS	26.8
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	11” x 8.1” x 4.5”
FINISH	Clear Anodized
RATING	IP
LISTING	CSA

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	2500
ANTICIPATED LIFE	55,000

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES

Recessed mount fixed downlight with one (1) LED lighting source, 2500 delivered lumens, 3000K color engine, 80+ CRI, 45° optic. Downlight should operate on 120-277 voltage and be supplied with a 0-10v control option down to 0.1% and include a minimum 5-year warranty with a 55,000 hour anticipated life. Downlight to have clear anodized finish. Downlight should be CSA listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

gotham | I V O™

Luminaire Type:

Catalog Number:

IVO™ 4" Round Downlight
New Construction

Parabolic

4.5" x 8.2" x 11.0"

New construction housing shown. Please see page 6 for full set of dimensional drawings.

TRIM STYLES AND COLORS

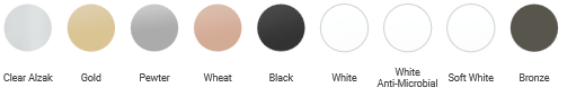
Flange Styles

Flanged

Flangeless

Flangeless in Millwork

Reflector Colors



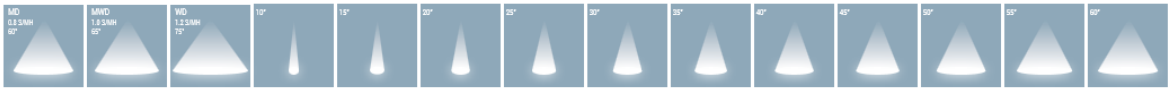
Clear Alzak | Gold | Pewter | Wheat | Black | White | White Anti-Microbial | Soft White | Bronze

QUICK SPECIFICATIONS

Feature Set

- Perfect Color™ consistency within ½-step MacAdam Ellipse
- Exceptional color rendering with 80 CRI, 90 CRI, or 95 CRI minimum
- Bounding Ray™ optical design delivers low brightness apertures for a comfortable lighting experience
- 45° visual cut-off angle to source
- Up to 90% lumen maintenance at 55,000 hours
- Wet Location optional, covered ceiling
- Easy installation and servicing with snap-in Driver
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture
- Clean beams with soft transitions from narrow spot up to wide flood distributions
- Field changeable optics available every 5°

Distribution / Beam Angles



Superior Perfomance*

Nominal Lumens	05LM	07LM	10LM	15LM	20LM	25LM	30LM	35LM	40LM	45LM
Delivered Lumens	493	735	991	1486	1968	2447	2732	3313	3796	4236
Wattage	5.1	7.3	9.8	15.0	20.5	26.8	29.7	34.4	41.8	45.3
Lumens per Watt	96	100	101	99	96	91	92	96	91	94

*Based on 3500K MWD 80CRI P AR LSS

PRODUCT FAMILY

IVO 4" Round Product Family

Downlight

Lensed WW

Surface Cylinder

Pendant Cylinder

Wall Cylinder

Wall Adjustable Cylinder

NOM | ds | LOW UGR | WET LOCATION | RoHS COMPLIANT | nLIGHT

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

Design Select options indicated by this color background.
Maximum order quantity for design select lead times is 100

Luminaire Type:

Catalog Number:

EXAMPLE: IVO4 D 10LM 35K 80CRI MWD MIN10 MVOLT ZT NCH P AR LSS F

ORDERING INFORMATION

Series	Function	Lumen Packages	Kelvin Temperature	Color Rendering Index	Distribution
IVO4 4" Round Recessed	D Downlight	05LM[1] 500 Lumens 07LM 750 Lumens 10LM 1000 Lumens 15LM 1500 Lumens 20LM 2000 Lumens 25LM 2500 Lumens 30LM 3000 Lumens 35LM 3500 Lumens 40LM[16] 4000 Lumens 45LM[17] 4500 Lumens	27K 2700K 30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80+ CRI 90CRI[2] 90+ CRI 95CRI[2] 95+ CRI	Narrow / Flood 10D 10° 30D 30° 50D 50° 15D 15° 35D 35° 55D 55° 20D 20° 40D 40° 60D 60° 25D 25° 45D 45° General Illumination / Batwing MD Medium Batwing (0.8 s/mh, 60°) MWD Medium Wide Batwing (1.0 s/mh, 65°) WD Wide Batwing (1.2 s/mh, 75°)

Dimming Level	Voltage	Control Input[18]	Emergency Option
MIN10 Min 10% Dim Level MIN1 Min 1% Dim Level DARK Min 0.1% Dim Level, Dim-to-Dark	MVOLT Multi-Volt input, 120V-277V 120 120V input 347[3] 347V input	ZT[4] Generic 0-10V EZT EldoLED 0-10V ELV[6] Phase Dimming (Forward/Reverse) (120V only) DMX[6] DMX DALI[6] DALI-2 NLIGHT Embedded wired controls by nLight NLTAIR2 Embedded wireless controls by nLight NLIGHTER Embedded wired controls by nLight with UL924 listed emergency operation NLTAIREM2 Embedded wireless controls by nLight with UL924 listed emergency operation	(Blank) No Emergency Pack E7W[8] IOTA 7W Emergency battery pack, Constant Power, Title 20 compliant, integrated test switch. E7WR[7,8] IOTA 7W Emergency battery pack, Constant Power, Title 20 compliant, remote test switch. E10W[9] IOTA 10W Emergency battery pack, Constant Power, Title 20 compliant, integrated test switch E10WR[9] IOTA 10W Emergency battery pack, Constant Power, Title 20 compliant, remote test switch. GTD[9,10] Generator Transfer Device

Housing Style	Options	Trim Style	Trim Color	Trim Finish	Flange Style
NCH Non-IC Housing (new construction only) ICAT IC/Airtight Housing (new construction only).. 1500LM max. CP Chicago Plenum CCEA Housing (new construction only)	SF Single Fuse, specify 120 or 277 WL Wet Location	P Open Reflector	AR Clear Anodized BR Black Anodized GR Gold Anodized PR Pewter Anodized WTR Wheat Anodized WR[11,15] White Gloss (painted) WMR[11] Soft White Matte (painted) WRAMF[11] White Gloss with Anti-Microbial (painted) BZR[11,15] Dark Bronze (painted) TRALTBD[12] Trim RAL # (TBD for pricing only) TCPC Trim Custom Paint Color	LD Matte Diffuse LS Specular LSS Semi Specular	F Self Flanged (color matches trim) FL Flangeless (Drywall) FLM[19] Flangeless Millwork FBL[13] Flange Only Black FWR[14] Flange Only White FRALTBD[12] Flange Only RAL FCPC Flange Only Custom Paint Color

ORDERING NOTES

1. 05LM only available with ELV or ZT. Not available with 347V.
2. 90CRI not available with 50K, 95CRI not available with 35K, 40K or 50K.
3. 347 only available with ZT and MIN1 or MIN10. Not available with nLight or Emergency options. 40LM max.
4. ZT is not available with DARK.
5. ELV only available with MIN1 and 120V.
6. DMX and DALI are only available with DARK.
7. E7WR is not available with CP housings.
8. E7W and E7WR and not available with ICAT.
9. E10W, E10WR and GTD not available with ICAT or CP.
10. GTD only available with NCH and ZT, ELV, or EZT.
11. Not available with Trim Finishes.
12. Replace with applicable RAL number and finish when ready to order. See RAL BROCHURE for available color options.
13. For use with different reflector flange color only (i.e AR, BZR, GR, PR, WR, WTR, WMR, WRAMF). Not available with BR (black reflector) or FL or FLM (flangeless) options.
14. For use with different reflector flange color only (i.e AR, BR, BZR, GR, PR, WTR). Not available with WR, WMR, WRAMF (white reflector) or FL or FLM (flangeless) options.
15. Corrosion Resistant Powder Coat.
16. 40LM and CP requires Marked Spacing.
17. 45LM and NCH requires Marked Spacing.
18. Refer to Tech-240 for compatible dimmers.
19. FLM requires Millwork Ceiling Cutout Template accessory, IVO*FLMKIT. Millwork Router Bit accessory, IVOFLMBIT, is optional or use similar. Millwork Adapter is included.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

ACCESSORIES – order as separate catalog numbers (shipped separately)	
GRA4-6IVO	Round goof ring adapter 4" ID, 6.5" OD
SCA4	Sloped ceiling adaptor. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA4 10D. Refer to TECH-190 for details.
CTAIVODL20	Trim ceiling thickness adaptors for 1-1/4" to 2" thick ceilings and ≤ 30LM (includes set of two for one trim).
CTAIVODL27	Trim ceiling thickness adaptors for 2" to 2-3/4" thick ceilings and ≤ 30LM (includes set of two for one trim).
CTAIVODL30	Trim ceiling thickness adaptors for 2-3/4" to 3" thick ceilings and ≤ 30LM (includes set of two for one trim).
IVO4FLMKIT	IVO 4" Round Flangeless in Millwork Ceiling Cutout Template (min. 1 required per install)
IVOFLMBIT	IVO Flangeless in Millwork Straight Router Bit, ¼" Shank with Bearing (optional)
IVO4OPTC D MD	Field Replaceable 4" Downlight Optic, Medium Batwing Distribution, 0.8 s/mh
IVO4OPTC D MWD	Field Replaceable 4" Downlight Optic, Medium Wide Batwing Distribution,1.0 s/mh
IVO4OPTC D WD	Field Replaceable 4" Downlight Optic, Wide Batwing Distribution, 1.2 s/mh
IVO4OPTC D 10D	Field Replaceable 4" Downlight Optic, 10°
IVO4OPTC D 15D	Field Replaceable 4" Downlight Optic, 15°
IVO4OPTC D 20D	Field Replaceable 4" Downlight Optic, 20°
IVO4OPTC D 25D	Field Replaceable 4" Downlight Optic, 25°
IVO4OPTC D 30D	Field Replaceable 4" Downlight Optic, 30°
IVO4OPTC D 35D	Field Replaceable 4" Downlight Optic, 35°
IVO4OPTC D 40D	Field Replaceable 4" Downlight Optic, 40°
IVO4OPTC D 45D	Field Replaceable 4" Downlight Optic, 45°
IVO4OPTC D 50D	Field Replaceable 4" Downlight Optic, 50°
IVO4OPTC D 55D	Field Replaceable 4" Downlight Optic, 55°
IVO4OPTC D 60D	Field Replaceable 4" Downlight Optic, 60°

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

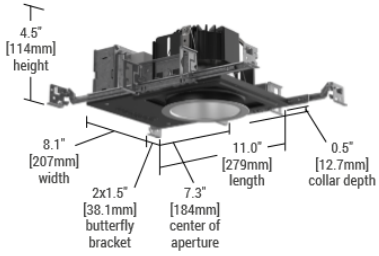
GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

DIMENSIONAL DATA

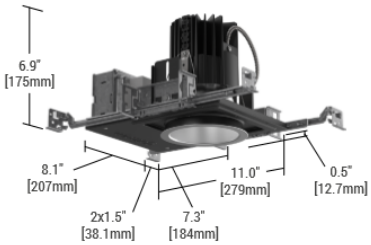
New Construction Dimensions

- Dimensions in inches [millimeters] are overall width and height (including mounting hardware Butterfly Brackets / Hanger Bars), length excludes extendable Hanger Bars.
- ½" clearance on all sides from non-combustible materials for non-IC applications required, unless marked spacing is noted otherwise.
- nLight Air Antenna extends 1.5" off the end of the j-box (lengthwise).
- Ceiling cutout for Flanged or Flangeless Trim is 5.0"
- Fixture with Marked Spacing require the following clearances (min): 24" center-to-center, 12" center to side building member, 2" overhead to building member
- Hanger Bars are extendable from 8.5" to 24".

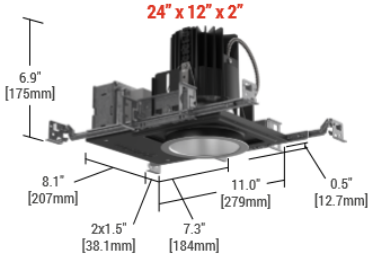
Non-IC Housing (NCH) For 05LM to 30LM



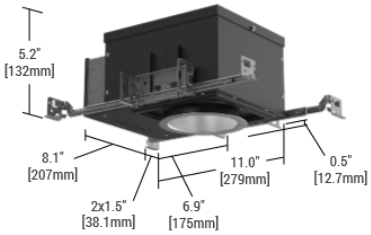
Non-IC Housing (NCH) For 35LM to 40LM



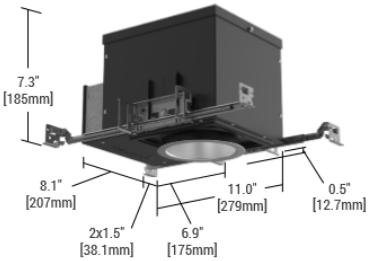
Non-IC Housing (NCH) For 45LM – MARKED SPACING 24" x 12" x 2"



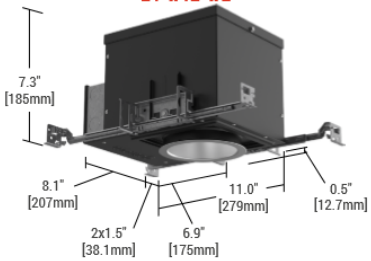
Chicago Plenum Housing (CP) For 05LM to 25LM



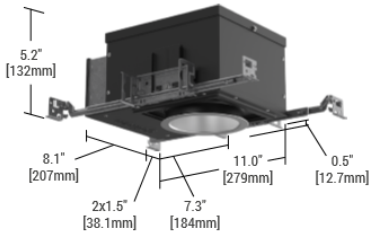
Chicago Plenum, New Construction Housing (CP) For 30LM to 35LM



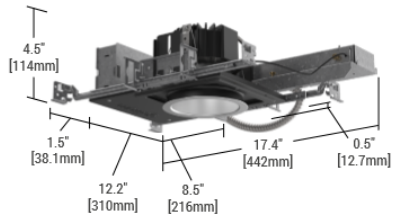
Chicago Plenum Housing (CP) For 40LM – MARKED SPACING 24" x 12" x 2"



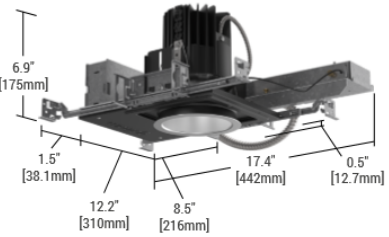
IC rated Housing (ICAT) For 05LM to 15LM



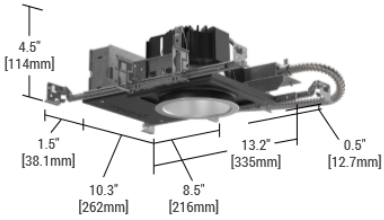
Non-IC Housing (NCH) with E7Wx, E10Wx Emergency Battery For 07LM to 30LM



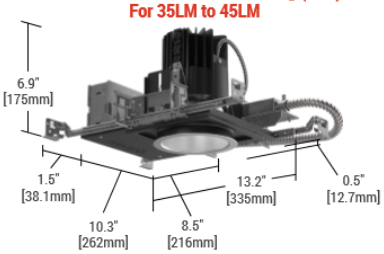
Non-IC Housing (NCH) with E7Wx, E10Wx Emergency Battery For 35LM to 45LM



Generator Transfer Device Housing (GTD) For 07LM to 30LM



Generator Transfer Device Housing (GTD) For 35LM to 45LM



GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

TRIM OPTIONS

Trim Style and Flange Option

- Dimensions in inches [millimeters]

Parabolic Flanged
(P) (F)

Parabolic Flangeless
(P) (FL)

Parabolic Flangeless Millwork
(P) (FLM)

Parabolic Flange Outer Diameter:	ø5.5"	[140]
Parabolic Flangeless / Millwork Outer Diameter:	ø4.8"	[121]
Parabolic Inner Diameter:	ø4.3"	[109]
Parabolic Aperture Diameter:	ø3.0"	[77]

Trim Color

Clear Anodized
(AR)

Soft White
Matte Painted
(WMR)

Black Anodized
(BR)

Gold Anodized
(GR)

Pewter Anodized
(PR)

Wheat Anodized
(WTR)

Dark Bronze
Gloss Painted
(BZR)

White
Gloss Painted
(WR)

White Anti-Microbial
Gloss Painted
(WRAMF)

Parabolic Flanged shown.

Optical Finish

Semi-Specular
(LSS)

Specular
(LS)

Matte Diffuse
(LD)

Clear Anodized shown.

Note: These colors were carefully reproduced to give as true a depiction as possible of the finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please contact a Gotham representative for an Architectural Color Chip Kit (GCOLORS KIT), consisting of Powder-Coated and Plated Finishes.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

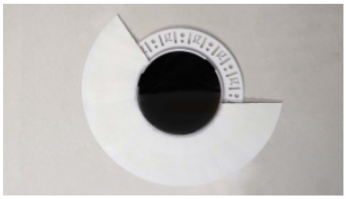
FLANGELESS

Flangeless Installation

Gotham's flangeless option utilizes a micro-thin polymer mud ring that minimizes the amount of drywall compound required to finish the ceiling. The end result is a virtually undetectable flangeless downlight installation.

The polymer mud ring is installed independent of the of the recessed frame, therefore floating with the ceiling. This innovation minimizes any surface cracks during reflector installation, ceiling movement and any future service to the recessed frame, wiring, electronics, etc.

Partially finished mud ring, showing cross-section detail.

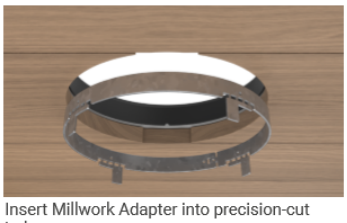


An IVO downlight requires only approximately 3" of plaster to finish.

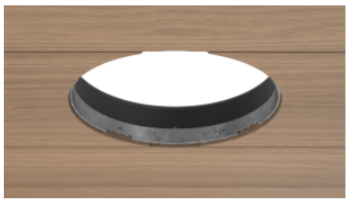
IVO with flangeless trim

Flangeless Millwork Installation

IVO's Flangeless in Millwork solution makes installation easy and precise. First, cut a hole in the Wood Ceiling using the Millwork Cutout Template (sold separately). Second, once Housing and ceiling are mounted in place, insert sheet metal Millwork Adapter (provided) lining up edge of tab with bottom of ceiling. Third, secure in place using finishing nails (provided) then remove tabs from Millwork Adapter. Last, install Trim!



Insert Millwork Adapter into precision-cut hole.



Secure with finishing nails.

Insert Trim and Module.

TABLES OF USE

Dimming Configurations

Dimming Level		Control Input	Dimming Level	Driver Dim Curve	Recommended Control Dim Curve
MIN10	+	ZT	100% to 10%	Linear	Linear/Logarithmic
	+	EZT	100% to 10%	Linear	Linear/Logarithmic
MIN1	+	ZT	100% to 1%	Linear	Linear/Logarithmic
	+	EZT	100% to 1%	Linear	Linear/Logarithmic
	+	ELV	100% to 1%*	n/a	n/a
DARK	+	EZT	100% to 0.1%	Logarithmic	Linear
	+	DMX	100% to 0.1%	Square	Linear
	+	DALI	100% to 0.1%	Logarithmic	Linear

* ELV Minimum Dimming level depends on dimmer and dimmer load

Embedded Nlight Configurations

Dimming Level		Control Input	Dimming Level	Control Provided	Driver Provided
MIN10	+	NLIGHT	100% to 10%	NIO EZDXA	eldoLED ECOdrive
	+	NLIGHTER	100% to 10%	NIO EZDCL ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 10%	RIO EZDL G2	eldoLED ECOdrive
	+	NLTAIREM2	100% to 10%	RIO EZDL EM G2	eldoLED ECOdrive
MIN1	+	NLIGHT	100% to 1%	NIO EZDXA	eldoLED ECOdrive
	+	NLIGHTER	100% to 1%	NIO EZDCL ER	eldoLED ECOdrive
	+	NLTAIR2	100% to 1%	RIO EZDL G2	eldoLED ECOdrive
	+	NLTAIREM2	100% to 1%	RIO EZDL EM G2	eldoLED ECOdrive
DARK	+	NLIGHT	100% to 0.1%	NIO EZDXA	eldoLED SOLOdrive
	+	NLIGHTER	100% to 0.1%	NIO EZDCL ER	eldoLED SOLOdrive
	+	NLTAIR2	100% to 0.1%	RIO EZDL G2	eldoLED SOLOdrive
	+	NLTAIREM2	100% to 0.1%	RIO EZDL EM G2	eldoLED SOLOdrive

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

P = Output Power/Wattage of Emergency Battery Driver (E7WR* = 7W, E10WR* = 10W, E15WR* = 15W)

LPW = Lumen per Watt rating of luminaire based on Ordering Code selections

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

SPECIFICATIONS

Optical System
- Bounding Ray™ optical design delivers low brightness apertures for a comfortable lighting experience and ensures no source image up to cut-off angle, minimizing glare.
- 45° visual cut-off angle to source
- Top-Down Flash characteristics avoids flash on trim until source becomes visible.
- Batwing distributions with feathered edges to provide even illumination fixture-to-fixture. Available with 0.8, 1.0, and 1.2 spacing-to-mounting-height ratio (s/mh).
- Clean beams with soft transitions from narrow spot up to wide flood distributions with optics available every 5°
- Optics are field changeable (tool-free).

LED Light Engine
- Perfect Color™ consistency within ½-step MacAdam Ellipse using proprietary pick and place algorithm
- 90% lumen maintenance at 55,000 hours.
- Available in 80, 90, or 95 CRI. 90CRI has R9 greater than 50, 95 CRI has R9 greater than 80.

Trims
- Trims are field changeable via twist-lock (tool-free).
- Trims are available in 9 colors and 3 surface finishes (standard)
- Custom RAL and Paint colors available upon request.
- Wall Wash and Downlight Trims are designed to be interchangeable.

Electrical
- 120, 347, or Multi-Volt (MVOLT) 120-277 VAC input at 50/60 Hz
- Power Factor > 85%
- Input wires 18 AWG, 600V minimum, copper
- Fixtures are ROHS compliant

EMI/RFI
- EMI/RFI per FCC Title 47 CFR, Part 15, Class A rated standard.

Controls (Optional)
- Luminaire can be equipped with interface for nLight wired, allowing it to communicate over an nLight network. Couple with nLight-enabled sensors, power packs, or WallPods using CAT-5 cabling to create an nLight Control Zone. Link Control Zone to a Gateway directly or via a Bridge for remote status monitoring and control using SensorView software.
- Luminaire can be equipped with interface for nLight Air, allowing it to communicate over the wireless nLight control platform. Can be paired to other luminaires and wall switches through CLAIRITY+, a mobile app, which allows individual fixture control.

Dimming
- Luminaire Is capable of continuous dimming without perceivable flicker (stroboscopic) as measured by flicker index (ASNI/IES RP-16-10).
- Available dimming ranges include: 100%-10% (MIN10), 100%-1% (MIN1), and 100%-0.1% (DARK) of rated lumen output.
- Available with smooth shut off function from minimum dimming level to 0%.
- EldoLED drivers (EZT, DALI) conform to IEEE P1789 standards.
- Drivers are inaudible in 24dB environment and stable even when input voltage conditions experience typical commercial environment fluctuations.

Emergency Battery (Optional)
- Luminaires equipped with battery pack (E7W, E10W, E15W) comply with NFPA 101 (Life Safety Code) and deliver constant light output for a duration of 90 minutes minimum with AC power loss.
- Emergency battery is CEC T20 compliant.

Installation
- Patent-pending Wire-Form Mounting Springs with custom profile facilitates effortless installation, maintains tension across various ceiling thicknesses, and ensures a snug-fit of the trim to the ceiling with no sag.
- Plug-in Driver design allows for quick and easy installation and servicing.
- Light Engine, Driver, Housing, and Trim can be installed tool-free.
- Ceiling Thickness Adapters available for 1.25" to 3" thick ceilings.

Construction
- Access to Light Engine, Driver, and branch circuit conductors is available from below the ceiling without the use of tools.
- Universal Mounting Butterfly Brackets can adjust vertically 2.5" and accept various mounting bars including ¾" and 1-1/2" C Channel, ½" or ¾" Flat Strap, ½" Conduit, and ½" Angle Bars, as well as standard Hanger Bars (included).
- Hanger Bars are extendable from 8.5" to 24".
- Luminaire is constructed with 20 gauge min cold-rolled steel, galvanized steel, and aluminum.

Listings
- Fixtures are CSA certified to meet US and Canadian standards.
- Fixtures are NOM certified to meet Mexican standards
- All fixtures are manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" per UL.
- Damp Location standard.
- Wet Location available, covered ceiling.

Photometrics
- All photometry is conducted by IESNA standard LM-79-08 in an accredited lab.
- LEDs are tested to LM-80 standards. Lumen maintenance is calculated via TM-21.

Warranty
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:
- Actual performance may differ as a result of end-user environment and application.
- All values are design or typical values, measured under laboratory conditions at 25 °C.
- The product images shown are for illustration purposes only and may not be an exact representation of the product.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

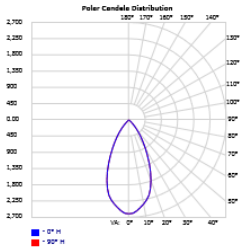
To learn more about A+, visit www.acuitybrands.com/aplus.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

PHOTOMETRY

MD Medium Beam

IVO4 D 20LM 35K 80CRI MD P AR LSS



Wattage: 20.5, Lumens: 1920, LPW: 94, S/MH: ..8, Test No: 24-850-22P801

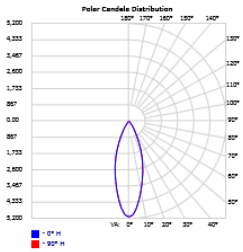
Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

35 Degree Beam

IVO4 D 20LM 35K 80CRI 35D P AR LSS



Wattage: 20.5, Lumens: 2044.6, LPW: 100, S/MH: .54, Test No: 24-850-34P401

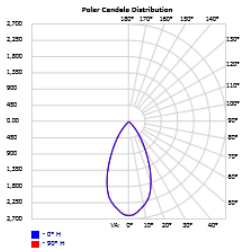
Candela Summary	
0°	5116
10°	3734
20°	2039
30°	675
40°	120
50°	14
60°	4
70°	2
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1778.1	87.0%
0-40	1992.7	97.5%
0-60	2040.2	99.8%
0-90	2044.6	100%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	79.94	4.8	4.8
10'	51.16	6	6
12'	35.53	7.2	7.2
14'	26.1	8.4	8.4
16'	19.99	9.6	9.6

50 Degree Beam

IVO4 D 20LM 35K 80CRI 45D P AR LSS



Wattage: 20.5, Lumens: 1920.1, LPW: 94, S/MH: .8, Test No: 24-850-11P809

Candela Summary	
0°	2603
10°	2366
20°	1784
30°	909
40°	319
50°	26
60°	6
70°	3
80°	1
90°	0

Zonal Lumen Summary		
Zone	Lumens	%
0-30	1435	74.7%
0-40	1798.4	93.7%
0-60	1914	99.7%
0-90	1920.1	100.0%

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter (ft)	
		Horizontal	Vertical
8'	40.67	7.6	7.6
10'	26.03	9.5	9.5
12'	18.07	11.4	11.4
14'	13.28	13.3	13.3
16'	10.17	15.2	15.2

CRI/CCT Multiplier Table		
CRI	CCT	Multiplier
80	2700K	0.92
	3000K	0.96
	3500K	1.00
	4000K	1.01
	5000K	1.04
90	2700K	0.80
	3000K	0.85
	3500K	0.85
	4000K	0.89
95	2700K	0.68
	3000K	0.75

Reflector Finish Multiplier		
Trim Color	Optical Finish	Multiplier
AR	LSS	1.00
AR	LS	1.06
AR	LD	0.97
GR	LSS	0.97
GR	LS	0.98
GR	LD	0.92
PR	LSS	0.97
PR	LS	0.97
PR	LD	0.90
BR	LSS	0.68
BR	LS	0.68
BR	LD	0.68
WTR	LSS	0.87
WTR	LS	0.89
WTR	LD	0.87
WR		1.03
WMR		1.03
WRAMF		1.04
BZR		0.68

UGR (70% 50% 20% reflectance using a 4H x 8H room size)						
Lumen Package	Crosswise			Endwise		
	MD	MWD	WD	MD	MWD	WD
05LM	0	0	0	0	0	0
07LM	0	0	0.7	0	0	0.7
10LM	0	0.1	1.8	0	0.1	1.8
15LM	1.4	1.5	3.2	1.4	1.5	3.2
20LM	2.4	2.5	4.2	2.4	2.5	4.2
25LM	3.1	3.3	4.9	3.1	3.3	4.9
30LM	3.8	3.9	5.6	3.8	3.9	5.6
35LM	4.2	4.3	6	4.2	4.3	6
40LM	4.7	4.8	6.4	4.7	4.8	6.4
45LM	5	5.2	6.8	5	5.2	6.8

*UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.

**Calculated using an AR (Clear reflector) with LSS (Semi-Specular) finish

UGR of zero for fixtures aimed at nadir with a cut-off equal to or less than 60deg per CIE 117-1995 Discomfort Glare in Interior Lighting. UGR FAQ

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

NLIGHT

nLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Embedded Controls

1. Install the luminaires with embedded controls
2. Install the nLight Wired wall switch
3. Connect the luminaires using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Embedded Controls

1. Install the luminaires with embedded controls
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY+ mobile app to pair the fixtures with the wall switch and if desired, customize the sensor settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

GOTHAM ARCHITECTURAL DOWNLIGHTING | 1 Acuity Way, Decatur, GA 30035 | P 800-705-SERV (7378) | gothamlighting.com
© 2014-2025 Acuity Brands Lighting Inc. All Rights Reserved. Rev. 07/16/25 Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Aculux
CATALOG NUMBER	AX4 A 27LM 30K 90CRI 30D EZB MVOLT 4AC CS SF
TOTAL WATTS	25
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	4.5" x 4.5"
FINISH	Clear Specular
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	30k
CRI	90+
LUMEN OUTPUT	2516
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount adjustable downlight with one (1) LED lighting source, 2516 delivered lumens, 30k color engine, 90+ CRI, 30° optic and integral driver. Downlight should operate on 120-277 voltage and be supplied with a 0-10v control option down to .01% and include a minimum 5-year warranty with a 50,000 hour anticipated life. Downlight to have clear specular finish. Downlight should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

D64
AX4 A 27LM 30K 90CRI 30D
EZB MVOLT 4AC CS SF

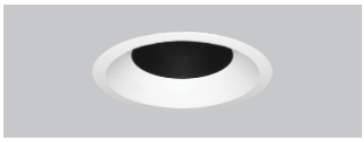
ACULUX

AX4 SERIES | 4" APERTURE

Adjustable Accent | 1200 – 3200 Lumens

TRIM STYLES

Angle-Cut Reflector



Bevel

FEATURES

SPOT ON! OPTICS

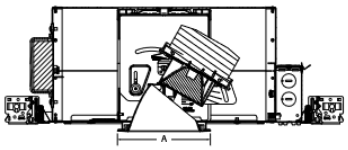
- Field Interchangeable TIR Optics in 9 distributions
- Accommodates up to 2 beam control lenses or filters

ACU-AIM™ PRECISION AIMING

- Precision geared hot-aiming provides 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in low aperture brightness

EXCEPTIONAL PERFORMANCE FROM 4-INCH APERTURE

- Up to 3115 lumens, 27,000 CBCP Delivered!
- Exceptionally consistent color with < 2SDCM for Static White & Tunable White; <1SDCM for WarmDim
- Excellent color rendition with 95+ CRI | 90+ R9 Available
- WarmDim® option mimics halogen dimming (3000K-1800K)
- Tunable White CCT range of 5000K –2700K



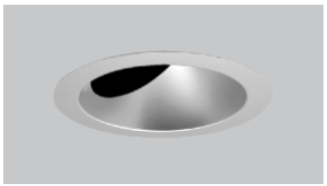
A Dimension:
Self Flanged: 5.7"
Flangeless: 4.9"

PERFORMANCE

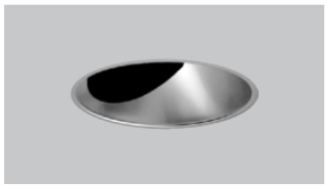
LUMEN PACKAGE	WATTS IN	DELIVERED LUMENS	EFFICACY (LPW)	MCBCP
Static White*				
12LM	9	1215	135	10407
17LM	13	1557	119	13342
22LM	19	2118	111	18145
27LM	25	2616	104	22415
32LM	33	3115	94	26685
WarmDim®				
08LM	16	736	46	14836
12LM	26	1174	45	14114
15LM	29	1433	49	11340
17LM	33	1589	48	12572
Tunable White				
12LM	19	1305	67	12640
17LM	28	1912	68	18519
22LM	38	2438	64	23616

*Performance with 4AC trim at 30K | 80CRI (Static White), 30K | 90CRI (WarmDim) & 50K | 90CRI (Tunable White)
Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25°C

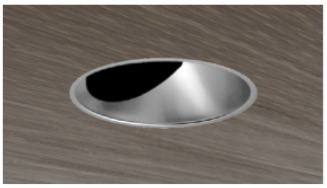
FLANGE STYLES



Self-Flanged



Flangeless (Gypsum)



Flangeless (Wood | Stone | Tile)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

D64
AX4 A 27LM 30K 90CRI 30D
EZB MVOLT 4AC CS SF

ACULUX

AX4 SERIES | 4" APERTURE

Adjustable Accent | 1200 – 3200 Lumens

ORDERING INFORMATION

EXAMPLE: AX4 A 27LM 30K 95CRI 24D FPC 120 ICAT 4ABV BD WHSF

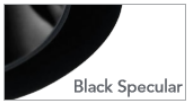
Housing Style	Lumens	CCT	CRI	Beam	Driver	Voltage[4]	Ratings	Options
AX4 A New Construction Adjustable	**Static White** 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens 27LM 2700 lumens 32LM[1] 3200 lumens	27K 2700K 30K 3000K 35K[2] 3500K 40K[2] 4000K	80CRI 90CRI 95CRI	12D 12° beam 20D 20° beam 24D 24° beam 30D 30° beam 35D 35° beam 40D 40° beam 45D 45° beam 50D 50° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 0-10V eldoLED | linear 1% min EZB 0-10V eldoLED | log <1% min EDXB eldoLED DMX | square <1% min EDAB eldoLED DALI 6 | log <1% min FPC Phase Cut Dimming | 1% min ECOD Lutron EcoSystem | 1% min	120 277 MVOLT (120-277)	(blank) Non-ICAT CP[5] Chicago Plenum ICAT[5] IC Rated, Air-tight	NLIGHT[6] nLight Dimming pack controls (Static White and WarmDim only) E6WT20R[7] Emergency 6W battery pack with remote test switch, T20 compliant
	WarmDim® 08LM 800 lumens 12LM 1200 lumens 15LM 1500 lumens 17LM 1700 lumens	WDIM HALR 3000K - 1800K	90CRI	10D[3] 10° beam 15D[3] 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50°x 20°	GZ1 0-10V | 1% min FPC Phase Cut Dimming | 1% min			
	Tunable White 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens	TUWH 5000K - 2700K	90CRI	15D 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 eldoLED 0-10V | linear 1% min EZB eldoLED 0-10V | log <1% min NLT[6] nLight nTune interface EDAB eldoLED DALI 6 | log <1% min EDABT8 eldoLED DALI 8 | log <1% min			

Trim	Reflector Finish	Flange Style	Trim Lens | Environment
Adjustable Reflector 4AC Angle Cut Reflector (0-45°) 4AC20 Shallow Cut Reflector (0-20°)	W White Paint CD Clear Diffuse CS Clear Specular BS Black Specular WTD Wheat Diffuse	*Flanged* SF Self Flanged WHSF Self Flanged, White Painted Flange (not available with W finish) *Flangeless*[8] FM Flangeless	(blank) Open | Damp Location WET[9] Solite | Wet Location
Bevel 4ABV BD Bevel Adjustable (0-45°)	**Bevel Finish & Flange Style** *Flanged* WHSF White, Flanged BLSF Black, Flanged *Flangeless*[8] WHFM White, Flangeless BLFM Black, Flangeless		(blank) Open | Damp WET Solite | Wet Location

Ceiling Installation	
Flanged	
(blank)	Ceiling Thickness < 0.875"
CTA4/125	Ceiling Thickness 0.875" - 1.25"
CTA4/163	Ceiling Thickness 1.25" - 1.625"
CTA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Gypsum)	
FMA4/087	Ceiling Thickness < 0.875"
FMA4/125	Ceiling Thickness 0.875" - 1.25"
FMA4/163	Ceiling Thickness 1.25" - 1.625"
FMA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Wood | Stone | Tile)[10]	
SFM4/087 (B,W)	Ceiling Thickness < 0.875"
SFM4/125 (B,W)	Ceiling Thickness 0.875" - 1.25"
SFM4/163 (B,W)	Ceiling Thickness 1.25" - 1.625"

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

REFLECTOR FINISHES



BEVEL FINISHES

ORDERING NOTES

1. 32LM not available with ICAT and CP.
2. 95CRI available on 27K and 30K only. Contact factory for other CCT/CRI combinations.
3. For WDIM, 10D only available with 08LM and 12LM; 15D only available with 15LM and 17LM.
4. MVOLT standard on GZ1, EZ1, EZB, ECOD, EDXB, EDAB, EDABT8, NLT (unless NLIGHT). Must be 120 for FPC.
5. CP or ICAT not available with 17LM WDIM or 22LM TUWH
6. Must specify 120 or 277 volts for NLIGHT; MVOLT for NLT. NLIGHT only available with EZ1, EZB (for static white) or GZ1 (for warmDim). NLT not available with CP.
7. E6WT20R not available with WDIM, TUWH, EDXB, CP, ICAT, or NLIGHT.
8. Must specify FMA4 or SFM4 option.
9. WET not available with 4AC20.
10. Specify finish: B = Black, W = White.

ACCESSORIES

Beam Control Lenses & Filters

DIFF 300	Diffuse Spread lens
SOLITE 300	Solite Uniformity Lens
PRISM 300	Prismatic Lens
LSPREAD 300	Linear Spread Lens
HCLBL 300	Hexcell Louver
UVF 300	UV Filter Lens
DCCF 300 HAL4250	Daylight Blue Correction

Replacement Optics

Static White Optics

4AXOPT/12D	12° Beam
4AXOPT/20D	20° Beam
4AXOPT/24D	24° Beam
4AXOPT/30D	30° Beam
4AXOPT/35D	35° Beam
4AXOPT/40D	40° Beam
4AXOPT/45D	45° Beam
4AXOPT/50D	50° Beam
4AXOPT/55D	55° Beam
4AXOPT/50D20D	50°x20° Beam

WarmDim Optics

4AXWDOPT/10D	10° Beam
4AXWDOPT/15D	15° Beam
4AXWDOPT/20D	20° Beam
4AXWDOPT/24D	24° Beam
4AXWDOPT/35D	35° Beam
4AXWDOPT/45D	45° Beam
4AXWDOPT/55D	55° Beam
4AXWDOPT/50D20D	50°x20° Beam

Tunable White Optics

4AXTWOPT/15D	15° Beam
4AXTWOPT/20D	20° Beam
4AXTWOPT/24D	24° Beam
4AXTWOPT/35D	35° Beam
4AXTWOPT/45D	45° Beam
4AXTWOPT/55D	55° Beam
4AXTWOPT/50D20D	50°x20° Beam

Optional Installation Accessories

Bar Hangers

HB1	Juno Real Nail® 3 Bar Hangers
HB26	26" C-Channel Bar Hangers
HB50	50" C-Channel Bar Hangers
LB27	27" Linear Bar Hangers

Note: Fixture supplied with Pro-Vi™ Bar Hangers

Emergency Inverter

IIS 35 HE	Up to 35W Remote Mount Micro Inverter (30LM Excluded)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PRODUCT SPECIFICATIONS

FIELD INTERCHANGEABLE LED LIGHT ENGINE
- Future proof and easy to maintain-serviceable from below the ceiling

Static White:
- <2SDCMBinning
- 2700K|3000K|3500K|4000K CCT
- 80 & 90CRI available for all CCTs
- 95+ CRI (>90 R9) available for 2700K, 3000K

WarmDim:
- Proprietary WarmDim technology mimics halogen,with CCT shifting from 3000K to 1800K when dimmed.
- <1SDCM Binning, 90+CRI

Tunable White:
- Tunable CCT range 5000K to 2700K
- <2 SDCM Binning, 90+ CRI

SPOT-ON! PRECISION OPTICS
- Field Interchangeable TIR Optics from 12° FWHM to 50° FWHM provide smooth, striation-free beams
- Patented self-adjusting optic holder accommodates up to 2 beam control lenses or filters (US Patent 8,950,911)
- UGR is zero for fixtures aimed at nadir with a cut-off equal to or less than 60°, per CIE 117-1996 Discomfort Glare in Interior Lighting. UGR FAQs

ACU-AIM™ PRECISION AIMING
- Precision Geared hot-aiming via Phillips screwdriver
- 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in maximum efficiency and low aperture brightness
- Numeric indicator marks allow contractor to pre-aim fixtures

HIGH QUALITY TRIMS
- Available with die cast bevels and spun aluminum reflectors.
- Available in Self Flanged and Flangeless
- Must Specify FMA4 for gypsum flangeless installation
- Must specify SFM4 for wood, stone, tile flangeless installation

FIELD REPLACEABLE DRIVER
- Accommodates 120-277V input and multiple control protocols down
- Dims without perceived flicker to <1% depending on driver specified
- Field replaceable without tools from below the ceiling
- >0.9 Power Factor

BUY AMERICAN ACT
- This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
- Please refer to www.acuitybrands.com/resources/buy-american for additional information.

WARRANTY & RATED LIFE
- LED is rated for >50,000 hours at 70% lumen maintenance
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

EMERGENCY BATTERY
- Provides a minimum of 700 lumens (4AC, 3000K, 80CRI) for minimum duration of 90 minutes.
- Accessible below ceiling for simple service; Self-Testing
- Supplied with Class-2 plenum rated remote test switch
- CEC T20 Compliant

NEW CONSTRUCTION MOUNTING
- Features patented (US Patent 8,038,113) Pro-VI™ bar hanger system offering compatible with wood stud and T-bar
- All fixtures also feature vertically adjustable mounting brackets (butterfly brackets)
- Centerline indicators on plaster frame and patented (US Patent 8,277,090) Tru-Line™ Platform featuring +/- ½" translation aids fixture alignment after installation, prior to finishing the ceiling.

JUNCTION BOX
- Rated for (4) No. 12 AWG 90°C through branch circuit conductors.
- Includes (6) ½", (1) ¾", (4) Non-metallic sheathed cable knock-outs.
- Push-in electrical connectors for field connections.

CODES & LABELS
- UL & cUL listed for through branch wiring, damp location
- Meets energy code Air Leakage requirements per ASTM E283
- ENERGY STAR® certified with select trims and housings
- Can be used to comply with Title 24, Part 6 with select trims and housings. Reference T24 JA-8 database for list of compliant housings and trims.
- ICAT Static White housings are rated for direct contact with insulation, including open and closed cell spray foam* with a maximum R-value of 7.2R/in. This allows use in ceiling cavities insulated up to R60.
- ICAT WarmDim and Tunable White housings are rated for direct contact with insulation, including open cell spray foam* with a maximum R-value of 3.8R/in. They are not suitable for use with closed cell spray foam. *Note: Options: "12LM WDIM", "ECOD", "EDXB", "NLT" & "NLIGHT" are excluded and not suitable for use with spray foam insulation.
- Union made

CEILING THICKNESS
- Accommodates ½" to 2" ceiling thickness

A+ CAPABLE LUMINAIRE
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning, when used with Acuity Brands controls products.
- All configurations of this luminaire are calibrated and tested to meet the Acuity Brand's specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications and testing, visit www.acuitybrands.com/aplus.

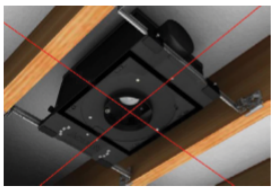
Spot On! Precision Optics

Smooth, striation-free beams with field-interchangeable TIR optics from 12° to 50°

Acu-Aim™ Precision Aiming

Precision geared hot-aiming is effortless. Centerbeam optics results in lower aperture brightness

Tru-Line™ Precision Installation

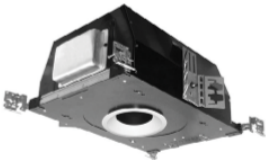


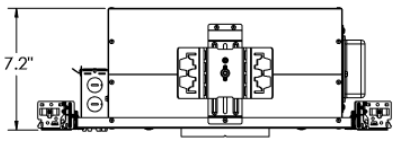
Pro-VI™ bar hangers, coupled with +/-1/2" aperture translation makes perfect installation achievable

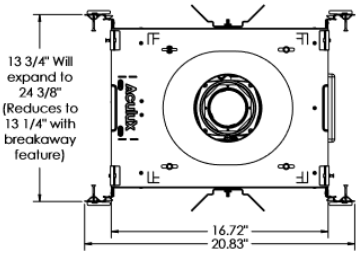
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMENSIONS

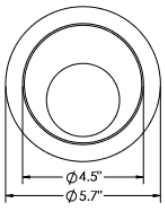
New Construction Adjustable (AX4 A)
ICAT/Non-ICAT: 12LM | 17LM | 22LM | 27LM
Non-ICAT: 32LM
Ceiling Cutout: 5-1/4" (refer to installation instructions for flangeless ceiling cutout)



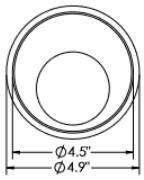




Reflector Trim (4AC & 4AC20)

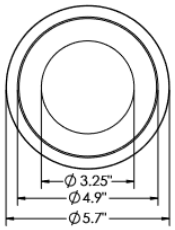


Flanged

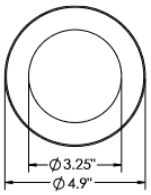


Flangeless

Bevel Trim (4ABV)



Flanged



Flangeless

ELECTRICAL SPECIFICATIONS

Static White

LUMEN PACKAGE	12LM		17LM		22LM		27LM		32LM	
Voltage	120	277	120	277	120	277	120	277	120	277
Input Watts	9.5	10.0	13.7	14.7	19.5	20.4	25.8	26.4	33.4	33.6
Input Current	0.08	0.04	0.11	0.06	0.16	0.08	0.22	0.10	0.28	0.13
Frequency	50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
Power Factor	0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

WarmDim

08LM		12LM		15LM		17LM	
120	277	120	277	120	277	120	277
16.1	16.5	25.6	25.9	28.9	29.0	32.8	32.9
0.14	0.06	0.21	0.10	0.24	0.11	0.27	0.12
50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

Tunable White

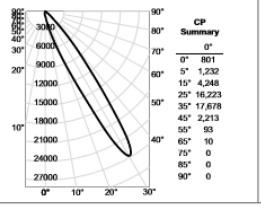
12LM		15LM		22LM	
120	277	120	277	120	277
18.2	19.5	27.2	28.0	36.9	37.5
0.15	0.08	0.23	0.11	0.31	0.14
50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.	

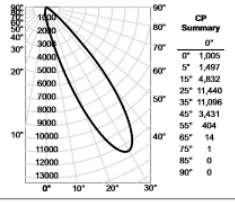
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

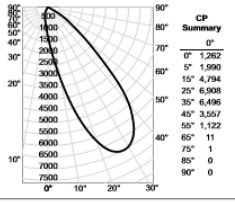
PHOTOMETRICS (@ 30° TILT) - 4AC

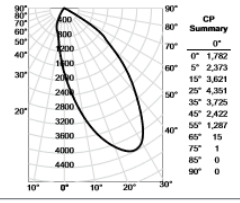
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4AC CS
Input Watts: 33.4, Delivered Lumens: 3146, LPW: 94.2, Test No: 20-421-23P198	Input Watts: 33.4, Delivered Lumens: 3062, LPW: 91.7, Test No: 20-421-25P198	Input Watts: 33.4, Delivered Lumens: 3087, LPW: 92.4, Test No: 20-421-27P198	Input Watts: 33.4, Delivered Lumens: 2886, LPW: 86.4, Test No: 20-421-30P198

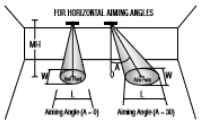




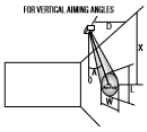




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0°				30°			30°					45°			
		MH	FC	L	W	FC	L	W	D	FC	X	L	W	FC	X	L	W
12D	26685	6	741	1.4	1.4	481	1.9	1.6	3	371	5.2	2.9	1.4	1048	3.0	1.4	1.0
		8	417	1.9	1.9	271	2.5	2.2	4	208	6.9	3.9	1.9	590	4.0	1.9	1.3
		10	267	2.3	2.3	173	3.1	2.7	5	133	8.7	4.9	2.3	377	5.0	2.4	1.6
		12	185	2.8	2.8	120	3.7	3.2	6	93	10.4	5.8	2.8	262	6.0	2.8	2.0
		14	136	3.3	3.3	88	4.4	3.8	7	68	12.1	6.8	3.3	193	7.0	3.3	2.3
24D	12566	4	785	1.7	1.7	510	2.4	2.0	2	393	3.5	4.1	1.7	1111	2.0	1.8	1.2
		6	349	2.6	2.6	227	3.5	3.0	3	175	5.2	6.1	2.6	494	3.0	2.7	1.9
		8	196	3.5	3.5	128	4.7	4.0	4	98	6.9	8.1	3.5	278	4.0	3.7	2.5
		10	126	4.4	4.4	82	5.9	5.0	5	63	8.7	10.2	4.4	178	5.0	4.6	3.1
		12	87	5.2	5.2	57	7.1	6.0	6	44	10.4	12.2	5.2	123	6.0	5.5	3.7
35D	7008	4	438	2.5	2.5	284	3.4	2.8	2	219	3.5	6.8	2.5	619	2.0	2.7	1.7
		6	195	3.7	3.7	126	5.1	4.2	3	97	5.2	10.3	3.7	275	3.0	4.1	2.6
		8	110	4.9	4.9	71	6.8	5.7	4	55	6.9	13.7	4.9	155	4.0	5.4	3.5
		10	70	6.1	6.1	46	8.4	7.1	5	35	8.7	17.1	6.1	99	5.0	6.8	4.3
		12	49	7.4	7.4	32	10.1	8.5	6	24	10.4	20.5	7.4	69	6.0	8.1	5.2
50D	4362	4	273	3.2	3.2	177	4.5	3.7	2	136	3.5	12.2	3.2	386	2.0	3.8	2.3
		6	121	4.8	4.8	79	6.7	5.5	3	61	5.2	18.3	4.8	171	3.0	5.7	3.4
		8	68	6.4	6.4	44	9.0	7.4	4	34	6.9	24.4	6.4	96	4.0	7.6	4.5
		10	44	8.0	8.0	28	11.2	9.2	5	22	8.7	30.5	8.0	62	5.0	9.5	5.6
		12	30	9.6	9.6	20	13.5	11.1	6	15	10.4	36.7	9.6	43	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

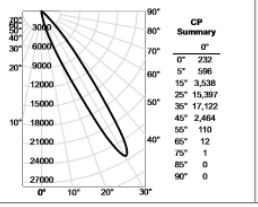
*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

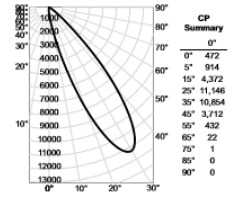
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

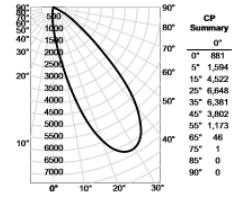
PHOTOMETRICS (@ 30° TILT) - 4ABV

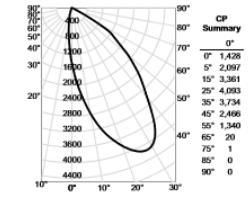
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4ABV BD
Input Watts: 33.4, Delivered Lumens: 2634, LPW: 78.9, Test No: 20-421-32P40	Input Watts: 33.4, Delivered Lumens: 2648, LPW: 79.3, Test No: 20-421-34P40	Input Watts: 33.4, Delivered Lumens: 2751, LPW: 82.4, Test No: 20-421-36P40	Input Watts: 33.4, Delivered Lumens: 2499, LPW: 74.8, Test No: 20-421-39P40

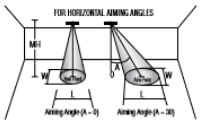




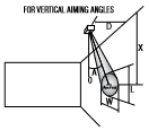




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0° MH	0° FC	0° L	0° W	30° FC	30° L	30° W	30° D	30° FC	30° X	30° L	30° W	45° FC	45° X	45° L	45° W
12D	26261	6	729	1.3	1.3	474	1.8	1.6	3	365	5.2	2.8	1.3	1032	3.0	1.4	1.0
		8	410	1.8	1.8	267	2.4	2.1	4	205	6.9	3.7	1.8	580	4.0	1.8	1.3
		10	263	2.2	2.2	171	3.0	2.6	5	131	8.7	4.7	2.2	371	5.0	2.3	1.6
		12	182	2.7	2.7	118	3.6	3.1	6	91	10.4	5.6	2.7	258	6.0	2.7	1.9
		14	134	3.1	3.1	87	4.2	3.6	7	67	12.1	6.5	3.1	189	7.0	3.2	2.2
24D	12278	4	767	1.7	1.7	498	2.3	2.0	2	384	3.5	4.0	1.7	1085	2.0	1.8	1.2
		6	341	2.6	2.6	222	3.5	3.0	3	171	5.2	6.0	2.6	482	3.0	2.7	1.8
		8	192	3.5	3.5	125	4.7	4.0	4	96	6.9	8.0	3.5	271	4.0	3.6	2.4
		10	123	4.3	4.3	80	5.9	5.0	5	61	8.7	10.1	4.3	174	5.0	4.5	3.1
		12	85	5.2	5.2	55	7.0	6.0	6	43	10.4	12.1	5.2	121	6.0	5.4	3.7
35D	6786	4	424	2.5	2.5	275	3.4	2.9	2	212	3.5	7.0	2.5	600	2.0	2.7	1.8
		6	189	3.7	3.7	122	5.1	4.3	3	94	5.2	10.4	3.7	267	3.0	4.1	2.6
		8	106	5.0	5.0	69	6.8	5.7	4	53	6.9	13.9	5.0	150	4.0	5.5	3.5
		10	68	6.2	6.2	44	8.5	7.1	5	34	8.7	17.4	6.2	96	5.0	6.8	4.4
		12	47	7.4	7.4	31	10.2	8.6	6	24	10.4	20.9	7.4	67	6.0	8.2	5.3
50D	4152	4	260	3.2	3.2	169	4.5	3.7	2	130	3.5	12.2	3.2	367	2.0	3.8	2.3
		6	115	4.8	4.8	75	6.7	5.5	3	58	5.2	18.3	4.8	163	3.0	5.7	3.4
		8	65	6.4	6.4	42	9.0	7.4	4	32	6.9	24.4	6.4	92	4.0	7.6	4.5
		10	42	8.0	8.0	27	11.2	9.2	5	21	8.7	30.5	8.0	59	5.0	9.5	5.6
		12	29	9.6	9.6	19	13.5	11.1	6	14	10.4	36.7	9.6	41	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMMER COMPATIBILITY

Phase Dimming (FPC) - Incandescent, Magnetic Low Voltage and Electronic Low Voltage Dimming

- Dimming range of 100% down to as low as 1% a minimum load of one fixture
- Dimming range and maximum rated load vary depending on dimmer type and model. See maximum load calculations below to identify max number of luminaires per dimmer.

Incandescent (INC) and Magnetic Low Voltage (MLV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 50%
(600/13W) X 0.5 = 23 Fixtures per Dimmer

Electronic Low Voltage (ELV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 75%
(600/13W) X 0.75 = 34 Fixtures per Dimmer

INCANDESCENT, MLV, ELV WALL DIMMERS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	Glyder	GLV*	MLV	2
Leviton	SureSlide	6633*	INC	2
Lutron	Diva	DVLV	MLV	6
Lutron	Diva	DV*	INC	2
Lutron	Skylark	SLV*	MLV	3
Lutron	RadioRA 2	RRD-6D*	INC	2
Lutron	RadioRA 2	RRD-10ND*	INC	2
Leviton	SureSlide	6613	MLV	5
Leviton	IllumaTech	IPL06-10Z*	INC	3
Lutron	Diva	DVCL	INC	3
Insteon	Keypad Dimmer	2334-232	INC	2
Insteon	Dimmer Switch	2477D*	INC	2
Control4	Forward Phase Dimmer	C4-FPD 120	INC	2
Lutron	Nova	NTELV	ELV	6
Lutron	Diva	DVELV*	ELV	2
Lutron	Lutron Maestro	MAELV*	ELV	5
Leviton	Vizia	VPE06-1LX	ELV	2
Leviton	Illumatech	IPE04*	ELV	5
Lutron	Lutron RadioRA2	RRD-6NA	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2
Lutron	RadioRA2	RRD-6NA*	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Sensor Switch	WPD	WPD*	INC	1
Leviton	Illmatech	IPM06-1LZ	MLV	3
Leviton	Illmatech	IPI06-1LZ	INC	2
Lutron	Diva	DVCL	INC	1
Leviton	SureSlide	6633*	INC	1
Leviton	SureSlide	6613*	MLV	1
Leviton	SureSlide	IPL06	INC	1
Control4	Forward phase dimmer	C4-FPD 120 FWD*	INC	1
Lutron	Diva	DVELV*	ELV	1
Lutron	Maestro	MAELV*	ELV	1
Lutron	Vive	MRF25-6ELV*	ELV	1
Lutron	Caseta	PD-5NE*	ELV	1
Leviton	Illumatech	IPE04	ELV	4
Lutron	Maestro	RRD-PRO REV	PHA	1
Control4	Phase Adaptive Dimmer	C4-APD 120*	PHA	1
Lutron	Maestro	RRD-PRO FWD*	PHA	1

INTEGRATED CONTROL SYSTEMS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	LP	LP-RPM-4U	INC	5
Lutron	LP	LP-RPM-4A*	PHA	2
Lutron	GrafikEye QS	QSGRJ-3P	PHA	2
Lutron	GrafikEye QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	2
Acuity	nLight nSP5PCD ELV	nSP5PCD*	ELV	4
Insteon	Micro Module Dimmer	2442-222*	INC	2
Control4	8 Ch Dimmer	C4-DIN-8DIM-E	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Acuity	nLight nSP5PCD ELV	nSP5PCD ELV*	ELV	1
Acuity	nLight nSP5PCD ELV	PCDM*	ELV	1
Acuity	Fresco LMPM	LMPM 2D 2L*	PHA	1
Lutron	LP	LP-RPM-4A *	PHA	1
Lutron	LP	LP-RPM-4U*	INC	1
Lutron	GrafikEye QS	Lutron PHPM-PA-120*	PHA	1
Lutron	GrafikEye QS	Lutron Grafik Eye QSGRJ-3P*	MLV	1
Lutron	HomeWorks QS	PHPM-PA-120*	PHA	1
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	1
Legrand	Wattstopper	LMRC-221-U*	PHA	1
Control4	8 Ch Dimmer	C4-DIN-8DIM-E*	PHA	1
Crestron	Phase Adaptive Dimmer	6501748*	PHA	1

*: Aculux recommended dimmers

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

0-10V Dimming (GZ1, EZ1, EZB drivers)

WALL DIMMERS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	Diva	DVTV	0-10V	1	<1
Lutron	Nova	NFTV	0-10V	1	<1
Lutron	Nova T	NTFTV	0-10V	1	<1

INTEGRATED CONTROL SYSTEMS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	GrafikEye QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVM2*	0-10V	1	<1
Lutron	LCP128	GRX-TVI*	0-10V	1	<1
Lutron	LCP128	GRX-TVM2*	0-10V	1	<1
Lutron	LP	GRX-TVM2*	0-10V	1	<1
Lutron	RadioRA2	LMJ-5T-DV-B	0-10V	1**	<1
Crestron	GreenLight	DIN-4DIMFLV4	0-10V	1	<1
Lutron	Energi Tripak	RMJ-5T-DV-B	0-10V	1	<1
Wattstopper	DLM	LMRC-211	0-10V	1	<1
Insteon	Ballast Dimmer	2475DA2	0-10V	1	<1

*: Aculux recommended dimmers
**: Not tested with -GZ1
+: Requires a separate relay module to turn luminaire on/off

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Aculux
CATALOG NUMBER	AX4 A 27LM 30K 90CRI 30D EZB MVOLT 4AC CS SF
TOTAL WATTS	25
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	4.5" x 4.5"
FINISH	Clear Specular
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	30k
CRI	90+
LUMEN OUTPUT	2516
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount adjustable downlight with one (1) LED lighting source, 2516 delivered lumens, 30k color engine, 90+ CRI, 35° optic and integral driver. Downlight should operate on 120-277 voltage and be supplied with a 0-10v control option down to .01% and include a minimum 5-year warranty with a 50,000 hour anticipated life. Downlight to have clear specular finish. Downlight should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

D64
AX4 A 27LM 30K 90CRI 30D
EZB MVOLT 4AC CS SF

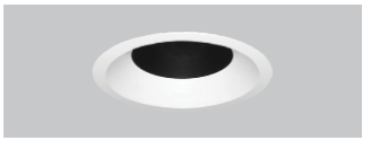
ACULUX

AX4 SERIES | 4" APERTURE

Adjustable Accent | 1200 – 3200 Lumens

TRIM STYLES

Angle-Cut Reflector



Bevel

FEATURES

SPOT ON! OPTICS

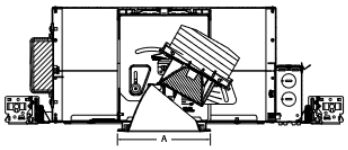
- Field Interchangeable TIR Optics in 9 distributions
- Accommodates up to 2 beam control lenses or filters

ACU-AIM™ PRECISION AIMING

- Precision geared hot-aiming provides 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in low aperture brightness

EXCEPTIONAL PERFORMANCE FROM 4-INCH APERTURE

- Up to 3115 lumens, 27,000 CBCP Delivered!
- Exceptionally consistent color with < 2SDCM for Static White & Tunable White; <1SDCM for WarmDim
- Excellent color rendition with 95+ CRI | 90+ R9 Available
- WarmDim® option mimics halogen dimming (3000K-1800K)
- Tunable White CCT range of 5000K –2700K



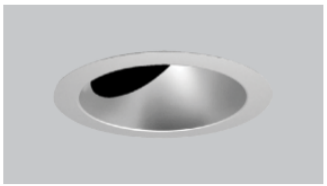
A Dimension:
Self Flanged: 5.7"
Flangeless: 4.9"

PERFORMANCE

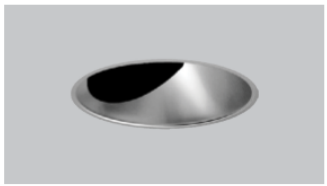
LUMEN PACKAGE	WATTS IN	DELIVERED LUMENS	EFFICACY (LPW)	MCBCP
Static White*				
12LM	9	1215	135	10407
17LM	13	1557	119	13342
22LM	19	2118	111	18145
27LM	25	2616	104	22415
32LM	33	3115	94	26685
WarmDim®				
08LM	16	736	46	14836
12LM	26	1174	45	14114
15LM	29	1433	49	11340
17LM	33	1589	48	12572
Tunable White				
12LM	19	1305	67	12640
17LM	28	1912	68	18519
22LM	38	2438	64	23616

*Performance with 4AC trim at 30K | 80CRI (Static White), 30K | 90CRI (WarmDim) & 50K | 90CRI (Tunable White)
Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25°C

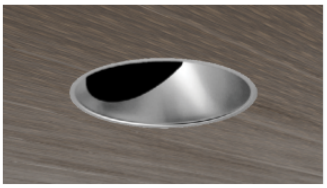
FLANGE STYLES



Self-Flanged



Flangeless (Gypsum)



Flangeless (Wood | Stone | Tile)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

D64
AX4 A 27LM 30K 90CRI 30D
EZB MVOLT 4AC CS SF

ACULUX

AX4 SERIES | 4" APERTURE

Adjustable Accent | 1200 – 3200 Lumens

ORDERING INFORMATION

EXAMPLE: AX4 A 27LM 30K 95CRI 24D FPC 120 ICAT 4ABV BD WHSF

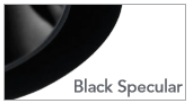
Housing Style	Lumens	CCT	CRI	Beam	Driver	Voltage[4]	Ratings	Options
AX4 A New Construction Adjustable	**Static White** 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens 27LM 2700 lumens 32LM[1] 3200 lumens	27K 2700K 30K 3000K 35K[2] 3500K 40K[2] 4000K	80CRI 90CRI 95CRI	12D 12° beam 20D 20° beam 24D 24° beam 30D 30° beam 35D 35° beam 40D 40° beam 45D 45° beam 50D 50° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 0-10V eldoLED | linear 1% min EZB 0-10V eldoLED | log <1% min EDXB eldoLED DMX | square <1% min EDAB eldoLED DALI 6 | log <1% min FPC Phase Cut Dimming | 1% min ECOD Lutron EcoSystem | 1% min	120 277 MVOLT (120-277)	(blank) Non-ICAT CP[5] Chicago Plenum ICAT[5] IC Rated, Air-tight	NLIGHT[6] nLight Dimming pack controls (Static White and WarmDim only) E6WT20R[7] Emergency 6W battery pack with remote test switch, T20 compliant
	WarmDim® 08LM 800 lumens 12LM 1200 lumens 15LM 1500 lumens 17LM 1700 lumens	WDIM HALR 3000K - 1800K	90CRI	10D[3] 10° beam 15D[3] 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50°x 20°	GZ1 0-10V | 1% min FPC Phase Cut Dimming | 1% min			
	Tunable White 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens	TUWH 5000K - 2700K	90CRI	15D 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 eldoLED 0-10V | linear 1% min EZB eldoLED 0-10V | log <1% min NLT[6] nLight nTune interface EDAB eldoLED DALI 6 | log <1% min EDABT8 eldoLED DALI 8 | log <1% min			

Trim	Reflector Finish	Flange Style	Trim Lens | Environment
Adjustable Reflector 4AC Angle Cut Reflector (0-45°) 4AC20 Shallow Cut Reflector (0-20°)	W White Paint CD Clear Diffuse CS Clear Specular BS Black Specular WTD Wheat Diffuse	*Flanged* SF Self Flanged WHSF Self Flanged, White Painted Flange (not available with W finish) *Flangeless*[8] FM Flangeless	(blank) Open | Damp Location WET[9] Solite | Wet Location
Bevel 4ABV BD Bevel Adjustable (0-45°)	**Bevel Finish & Flange Style** *Flanged* WHSF White, Flanged BLSF Black, Flanged *Flangeless*[8] WHFM White, Flangeless BLFM Black, Flangeless		(blank) Open | Damp WET Solite | Wet Location

Ceiling Installation	
Flanged	
(blank)	Ceiling Thickness < 0.875"
CTA4/125	Ceiling Thickness 0.875" - 1.25"
CTA4/163	Ceiling Thickness 1.25" - 1.625"
CTA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Gypsum)	
FMA4/087	Ceiling Thickness < 0.875"
FMA4/125	Ceiling Thickness 0.875" - 1.25"
FMA4/163	Ceiling Thickness 1.25" - 1.625"
FMA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Wood | Stone | Tile)[10]	
SFM4/087 (B,W)	Ceiling Thickness < 0.875"
SFM4/125 (B,W)	Ceiling Thickness 0.875" - 1.25"
SFM4/163 (B,W)	Ceiling Thickness 1.25" - 1.625"

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

REFLECTOR FINISHES



BEVEL FINISHES

ORDERING NOTES

1. 32LM not available with ICAT and CP.
2. 95CRI available on 27K and 30K only. Contact factory for other CCT/CRI combinations.
3. For WDIM, 10D only available with 08LM and 12LM; 15D only available with 15LM and 17LM.
4. MVOLT standard on GZ1, EZ1, EZB, ECOD, EDXB, EDAB, EDABT8, NLT (unless NLIGHT). Must be 120 for FPC.
5. CP or ICAT not available with 17LM WDIM or 22LM TUWH
6. Must specify 120 or 277 volts for NLIGHT; MVOLT for NLT. NLIGHT only available with EZ1, EZB (for static white) or GZ1 (for warmDim). NLT not available with CP.
7. E6WT20R not available with WDIM, TUWH, EDXB, CP, ICAT, or NLIGHT.
8. Must specify FMA4 or SFM4 option.
9. WET not available with 4AC20.
10. Specify finish: B = Black, W = White.

ACCESSORIES

Beam Control Lenses & Filters

DIFF 300	Diffuse Spread lens
SOLITE 300	Solite Uniformity Lens
PRISM 300	Prismatic Lens
LSPREAD 300	Linear Spread Lens
HCLBL 300	Hexcell Louver
UVF 300	UV Filter Lens
DCCF 300 HAL4250	Daylight Blue Correction

Replacement Optics

Static White Optics

4AXOPT/12D	12° Beam
4AXOPT/20D	20° Beam
4AXOPT/24D	24° Beam
4AXOPT/30D	30° Beam
4AXOPT/35D	35° Beam
4AXOPT/40D	40° Beam
4AXOPT/45D	45° Beam
4AXOPT/50D	50° Beam
4AXOPT/55D	55° Beam
4AXOPT/50D20D	50°x20° Beam

WarmDim Optics

4AXWDOPT/10D	10° Beam
4AXWDOPT/15D	15° Beam
4AXWDOPT/20D	20° Beam
4AXWDOPT/24D	24° Beam
4AXWDOPT/35D	35° Beam
4AXWDOPT/45D	45° Beam
4AXWDOPT/55D	55° Beam
4AXWDOPT/50D20D	50°x20° Beam

Tunable White Optics

4AXTWOPT/15D	15° Beam
4AXTWOPT/20D	20° Beam
4AXTWOPT/24D	24° Beam
4AXTWOPT/35D	35° Beam
4AXTWOPT/45D	45° Beam
4AXTWOPT/55D	55° Beam
4AXTWOPT/50D20D	50°x20° Beam

Optional Installation Accessories

Bar Hangers

HB1	Juno Real Nail® 3 Bar Hangers
HB26	26" C-Channel Bar Hangers
HB50	50" C-Channel Bar Hangers
LB27	27" Linear Bar Hangers

Note: Fixture supplied with Pro-Vi™ Bar Hangers

Emergency Inverter

IIS 35 HE	Up to 35W Remote Mount Micro Inverter (30LM Excluded)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PRODUCT SPECIFICATIONS

FIELD INTERCHANGEABLE LED LIGHT ENGINE
- Future proof and easy to maintain-serviceable from below the ceiling

Static White:
- <2SDCMBinning
- 2700K|3000K|3500K|4000K CCT
- 80 & 90CRI available for all CCTs
- 95+ CRI (>90 R9) available for 2700K, 3000K

WarmDim:
- Proprietary WarmDim technology mimics halogen,with CCT shifting from 3000K to 1800K when dimmed.
- <1SDCM Binning, 90+CRI

Tunable White:
- Tunable CCT range 5000K to 2700K
- <2 SDCM Binning, 90+ CRI

SPOT-ON! PRECISION OPTICS
- Field Interchangeable TIR Optics from 12° FWHM to 50° FWHM provide smooth, striation-free beams
- Patented self-adjusting optic holder accommodates up to 2 beam control lenses or filters (US Patent 8,950,911)
- UGR is zero for fixtures aimed at nadir with a cut-off equal to or less than 60°, per CIE 117-1996 Discomfort Glare in Interior Lighting. UGR FAQs

ACU-AIM™ PRECISION AIMING
- Precision Geared hot-aiming via Phillips screwdriver
- 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in maximum efficiency and low aperture brightness
- Numeric indicator marks allow contractor to pre-aim fixtures

HIGH QUALITY TRIMS
- Available with die cast bevels and spun aluminum reflectors.
- Available in Self Flanged and Flangeless
- Must Specify FMA4 for gypsum flangeless installation
- Must specify SFM4 for wood, stone, tile flangeless installation

FIELD REPLACEABLE DRIVER
- Accommodates 120-277V input and multiple control protocols down
- Dims without perceived flicker to <1% depending on driver specified
- Field replaceable without tools from below the ceiling
- >0.9 Power Factor

BUY AMERICAN ACT
- This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
- Please refer to www.acuitybrands.com/resources/buy-american for additional information.

WARRANTY & RATED LIFE
- LED is rated for >50,000 hours at 70% lumen maintenance
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

EMERGENCY BATTERY
- Provides a minimum of 700 lumens (4AC, 3000K, 80CRI) for minimum duration of 90 minutes.
- Accessible below ceiling for simple service; Self-Testing
- Supplied with Class-2 plenum rated remote test switch
- CEC T20 Compliant

NEW CONSTRUCTION MOUNTING
- Features patented (US Patent 8,038,113) Pro-VI™ bar hanger system offering compatible with wood stud and T-bar
- All fixtures also feature vertically adjustable mounting brackets (butterfly brackets)
- Centerline indicators on plaster frame and patented (US Patent 8,277,090) Tru-Line™ Platform featuring +/- ½" translation aids fixture alignment after installation, prior to finishing the ceiling.

JUNCTION BOX
- Rated for (4) No. 12 AWG 90°C through branch circuit conductors.
- Includes (6) ½", (1) ¾", (4) Non-metallic sheathed cable knock-outs.
- Push-in electrical connectors for field connections.

CODES & LABELS
- UL & cUL listed for through branch wiring, damp location
- Meets energy code Air Leakage requirements per ASTM E283
- ENERGY STAR® certified with select trims and housings
- Can be used to comply with Title 24, Part 6 with select trims and housings. Reference T24 JA-8 database for list of compliant housings and trims.
- ICAT Static White housings are rated for direct contact with insulation, including open and closed cell spray foam* with a maximum R-value of 7.2R/in. This allows use in ceiling cavities insulated up to R60.
- ICAT WarmDim and Tunable White housings are rated for direct contact with insulation, including open cell spray foam* with a maximum R-value of 3.8R/in. They are not suitable for use with closed cell spray foam. *Note: Options: "12LM WDIM", "ECOD", "EDXB", "NLT" & "NLIGHT" are excluded and not suitable for use with spray foam insulation.
- Union made

CEILING THICKNESS
- Accommodates ½" to 2" ceiling thickness

A+ CAPABLE LUMINAIRE
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning, when used with Acuity Brands controls products.
- All configurations of this luminaire are calibrated and tested to meet the Acuity Brand's specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications and testing, visit www.acuitybrands.com/aplus.

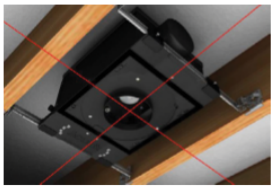
Spot On! Precision Optics

Smooth, striation-free beams with field-interchangeable TIR optics from 12° to 50°

Acu-Aim™ Precision Aiming

Precision geared hot-aiming is effortless. Centerbeam optics results in lower aperture brightness

Tru-Line™ Precision Installation

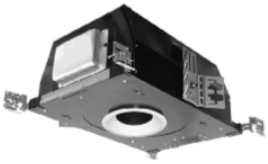


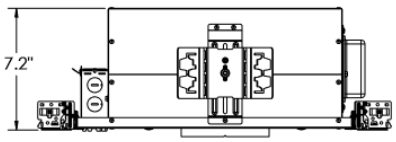
Pro-VI™ bar hangers, coupled with +/-1/2" aperture translation makes perfect installation achievable

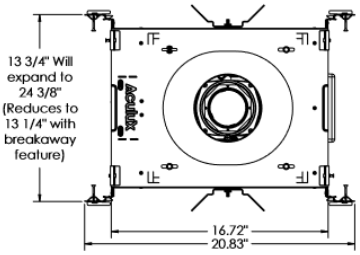
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMENSIONS

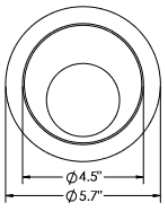
New Construction Adjustable (AX4 A)
ICAT/Non-ICAT: 12LM | 17LM | 22LM | 27LM
Non-ICAT: 32LM
Ceiling Cutout: 5-1/4" (refer to installation instructions for flangeless ceiling cutout)



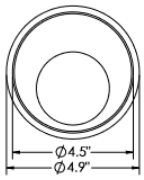




Reflector Trim (4AC & 4AC20)

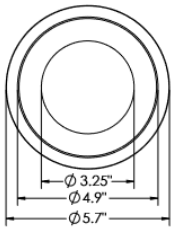


Flanged

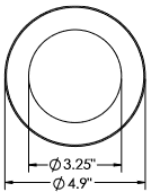


Flangeless

Bevel Trim (4ABV)



Flanged



Flangeless

ELECTRICAL SPECIFICATIONS

Static White

LUMEN PACKAGE	12LM		17LM		22LM		27LM		32LM	
Voltage	120	277	120	277	120	277	120	277	120	277
Input Watts	9.5	10.0	13.7	14.7	19.5	20.4	25.8	26.4	33.4	33.6
Input Current	0.08	0.04	0.11	0.06	0.16	0.08	0.22	0.10	0.28	0.13
Frequency	50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
Power Factor	0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

WarmDim

08LM		12LM		15LM		17LM	
120	277	120	277	120	277	120	277
16.1	16.5	25.6	25.9	28.9	29.0	32.8	32.9
0.14	0.06	0.21	0.10	0.24	0.11	0.27	0.12
50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

Tunable White

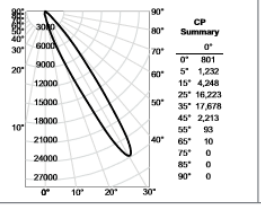
12LM		15LM		22LM	
120	277	120	277	120	277
18.2	19.5	27.2	28.0	36.9	37.5
0.15	0.08	0.23	0.11	0.31	0.14
50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.	

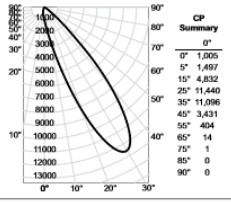
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

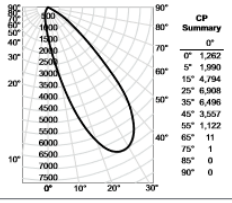
PHOTOMETRICS (@ 30° TILT) - 4AC

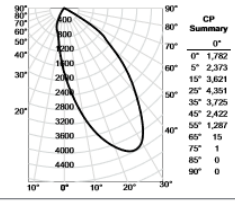
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4AC CS
Input Watts: 33.4, Delivered Lumens: 3146, LPW: 94.2, Test No: 20-421-23P198	Input Watts: 33.4, Delivered Lumens: 3062, LPW: 91.7, Test No: 20-421-25P198	Input Watts: 33.4, Delivered Lumens: 3087, LPW: 92.4, Test No: 20-421-27P198	Input Watts: 33.4, Delivered Lumens: 2886, LPW: 86.4, Test No: 20-421-30P198

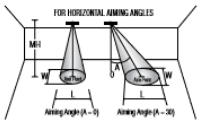




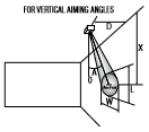




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0° MH	0° FC	0° L	0° W	30° FC	30° L	30° W	30° D	30° FC	30° X	30° L	30° W	45° FC	45° X	45° L	45° W
12D	26685	6	741	1.4	1.4	481	1.9	1.6	3	371	5.2	2.9	1.4	1048	3.0	1.4	1.0
		8	417	1.9	1.9	271	2.5	2.2	4	208	6.9	3.9	1.9	590	4.0	1.9	1.3
		10	267	2.3	2.3	173	3.1	2.7	5	133	8.7	4.9	2.3	377	5.0	2.4	1.6
		12	185	2.8	2.8	120	3.7	3.2	6	93	10.4	5.8	2.8	262	6.0	2.8	2.0
		14	136	3.3	3.3	88	4.4	3.8	7	68	12.1	6.8	3.3	193	7.0	3.3	2.3
24D	12566	4	785	1.7	1.7	510	2.4	2.0	2	393	3.5	4.1	1.7	1111	2.0	1.8	1.2
		6	349	2.6	2.6	227	3.5	3.0	3	175	5.2	6.1	2.6	494	3.0	2.7	1.9
		8	196	3.5	3.5	128	4.7	4.0	4	98	6.9	8.1	3.5	278	4.0	3.7	2.5
		10	126	4.4	4.4	82	5.9	5.0	5	63	8.7	10.2	4.4	178	5.0	4.6	3.1
		12	87	5.2	5.2	57	7.1	6.0	6	44	10.4	12.2	5.2	123	6.0	5.5	3.7
35D	7008	4	438	2.5	2.5	284	3.4	2.8	2	219	3.5	6.8	2.5	619	2.0	2.7	1.7
		6	195	3.7	3.7	126	5.1	4.2	3	97	5.2	10.3	3.7	275	3.0	4.1	2.6
		8	110	4.9	4.9	71	6.8	5.7	4	55	6.9	13.7	4.9	155	4.0	5.4	3.5
		10	70	6.1	6.1	46	8.4	7.1	5	35	8.7	17.1	6.1	99	5.0	6.8	4.3
		12	49	7.4	7.4	32	10.1	8.5	6	24	10.4	20.5	7.4	69	6.0	8.1	5.2
50D	4362	4	273	3.2	3.2	177	4.5	3.7	2	136	3.5	12.2	3.2	386	2.0	3.8	2.3
		6	121	4.8	4.8	79	6.7	5.5	3	61	5.2	18.3	4.8	171	3.0	5.7	3.4
		8	68	6.4	6.4	44	9.0	7.4	4	34	6.9	24.4	6.4	96	4.0	7.6	4.5
		10	44	8.0	8.0	28	11.2	9.2	5	22	8.7	30.5	8.0	62	5.0	9.5	5.6
		12	30	9.6	9.6	20	13.5	11.1	6	15	10.4	36.7	9.6	43	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

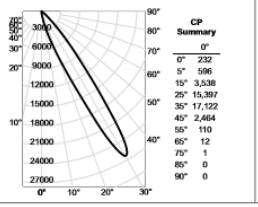
*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

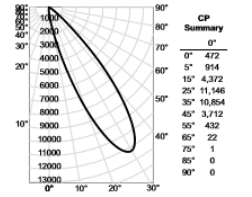
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

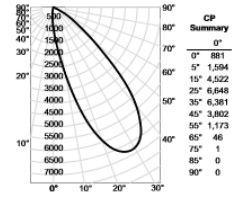
PHOTOMETRICS (@ 30° TILT) - 4ABV

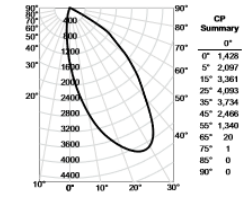
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4ABV BD
Input Watts: 33.4, Delivered Lumens: 2634, LPW: 78.9, Test No: 20-421-32P40	Input Watts: 33.4, Delivered Lumens: 2648, LPW: 79.3, Test No: 20-421-34P40	Input Watts: 33.4, Delivered Lumens: 2751, LPW: 82.4, Test No: 20-421-36P40	Input Watts: 33.4, Delivered Lumens: 2499, LPW: 74.8, Test No: 20-421-39P40

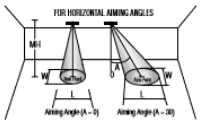




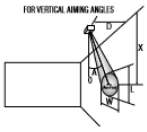




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0° MH	0° FC	0° L	0° W	30° FC	30° L	30° W	30° D	30° FC	30° X	30° L	30° W	45° FC	45° X	45° L	45° W
12D	26261	6	729	1.3	1.3	474	1.8	1.6	3	365	5.2	2.8	1.3	1032	3.0	1.4	1.0
		8	410	1.8	1.8	267	2.4	2.1	4	205	6.9	3.7	1.8	580	4.0	1.8	1.3
		10	263	2.2	2.2	171	3.0	2.6	5	131	8.7	4.7	2.2	371	5.0	2.3	1.6
		12	182	2.7	2.7	118	3.6	3.1	6	91	10.4	5.6	2.7	258	6.0	2.7	1.9
		14	134	3.1	3.1	87	4.2	3.6	7	67	12.1	6.5	3.1	189	7.0	3.2	2.2
24D	12278	4	767	1.7	1.7	498	2.3	2.0	2	384	3.5	4.0	1.7	1085	2.0	1.8	1.2
		6	341	2.6	2.6	222	3.5	3.0	3	171	5.2	6.0	2.6	482	3.0	2.7	1.8
		8	192	3.5	3.5	125	4.7	4.0	4	96	6.9	8.0	3.5	271	4.0	3.6	2.4
		10	123	4.3	4.3	80	5.9	5.0	5	61	8.7	10.1	4.3	174	5.0	4.5	3.1
		12	85	5.2	5.2	55	7.0	6.0	6	43	10.4	12.1	5.2	121	6.0	5.4	3.7
35D	6786	4	424	2.5	2.5	275	3.4	2.9	2	212	3.5	7.0	2.5	600	2.0	2.7	1.8
		6	189	3.7	3.7	122	5.1	4.3	3	94	5.2	10.4	3.7	267	3.0	4.1	2.6
		8	106	5.0	5.0	69	6.8	5.7	4	53	6.9	13.9	5.0	150	4.0	5.5	3.5
		10	68	6.2	6.2	44	8.5	7.1	5	34	8.7	17.4	6.2	96	5.0	6.8	4.4
		12	47	7.4	7.4	31	10.2	8.6	6	24	10.4	20.9	7.4	67	6.0	8.2	5.3
50D	4152	4	260	3.2	3.2	169	4.5	3.7	2	130	3.5	12.2	3.2	367	2.0	3.8	2.3
		6	115	4.8	4.8	75	6.7	5.5	3	58	5.2	18.3	4.8	163	3.0	5.7	3.4
		8	65	6.4	6.4	42	9.0	7.4	4	32	6.9	24.4	6.4	92	4.0	7.6	4.5
		10	42	8.0	8.0	27	11.2	9.2	5	21	8.7	30.5	8.0	59	5.0	9.5	5.6
		12	29	9.6	9.6	19	13.5	11.1	6	14	10.4	36.7	9.6	41	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMMER COMPATIBILITY

Phase Dimming (FPC) - Incandescent, Magnetic Low Voltage and Electronic Low Voltage Dimming

- Dimming range of 100% down to as low as 1% a minimum load of one fixture
- Dimming range and maximum rated load vary depending on dimmer type and model. See maximum load calculations below to identify max number of luminaires per dimmer.

Incandescent (INC) and Magnetic Low Voltage (MLV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 50%
(600/13W) X 0.5 = 23 Fixtures per Dimmer

Electronic Low Voltage (ELV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 75%
(600/13W) X 0.75 = 34 Fixtures per Dimmer

INCANDESCENT, MLV, ELV WALL DIMMERS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	Glyder	GLV*	MLV	2
Leviton	SureSlide	6633*	INC	2
Lutron	Diva	DVLV	MLV	6
Lutron	Diva	DV*	INC	2
Lutron	Skylark	SLV*	MLV	3
Lutron	RadioRA 2	RRD-6D*	INC	2
Lutron	RadioRA 2	RRD-10ND*	INC	2
Leviton	SureSlide	6613	MLV	5
Leviton	IllumaTech	IPL06-10Z*	INC	3
Lutron	Diva	DVCL	INC	3
Insteon	Keypad Dimmer	2334-232	INC	2
Insteon	Dimmer Switch	2477D*	INC	2
Control4	Forward Phase Dimmer	C4-FPD 120	INC	2
Lutron	Nova	NTELV	ELV	6
Lutron	Diva	DVELV*	ELV	2
Lutron	Lutron Maestro	MAELV*	ELV	5
Leviton	Vizia	VPE06-1LX	ELV	2
Leviton	Illumatech	IPE04*	ELV	5
Lutron	Lutron RadioRA2	RRD-6NA	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2
Lutron	RadioRA2	RRD-6NA*	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Sensor Switch	WPD	WPD*	INC	1
Leviton	Illmatech	IPM06-1LZ	MLV	3
Leviton	Illmatech	IPI06-1LZ	INC	2
Lutron	Diva	DVCL	INC	1
Leviton	SureSlide	6633*	INC	1
Leviton	SureSlide	6613*	MLV	1
Leviton	SureSlide	IPL06	INC	1
Control4	Forward phase dimmer	C4-FPD 120 FWD*	INC	1
Lutron	Diva	DVELV*	ELV	1
Lutron	Maestro	MAELV*	ELV	1
Lutron	Vive	MRF25-6ELV*	ELV	1
Lutron	Caseta	PD-5NE*	ELV	1
Leviton	Illumatech	IPE04	ELV	4
Lutron	Maestro	RRD-PRO REV	PHA	1
Control4	Phase Adaptive Dimmer	C4-APD 120*	PHA	1
Lutron	Maestro	RRD-PRO FWD*	PHA	1

INTEGRATED CONTROL SYSTEMS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	LP	LP-RPM-4U	INC	5
Lutron	LP	LP-RPM-4A*	PHA	2
Lutron	GrafikEye QS	QSGRJ-3P	PHA	2
Lutron	GrafikEye QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	2
Acuity	nLight nSP5PCD ELV	nSP5PCD*	ELV	4
Insteon	Micro Module Dimmer	2442-222*	INC	2
Control4	8 Ch Dimmer	C4-DIN-8DIM-E	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Acuity	nLight nSP5PCD ELV	nSP5PCD ELV*	ELV	1
Acuity	nLight nSP5PCD ELV	PCDM*	ELV	1
Acuity	Fresco LMPM	LMPM 2D 2L*	PHA	1
Lutron	LP	LP-RPM-4A *	PHA	1
Lutron	LP	LP-RPM-4U*	INC	1
Lutron	GrafikEye QS	Lutron PHPM-PA-120*	PHA	1
Lutron	GrafikEye QS	Lutron Grafik Eye QSGRJ-3P*	MLV	1
Lutron	HomeWorks QS	PHPM-PA-120*	PHA	1
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	1
Legrand	Wattstopper	LMRC-221-U*	PHA	1
Control4	8 Ch Dimmer	C4-DIN-8DIM-E*	PHA	1
Crestron	Phase Adaptive Dimmer	6501748*	PHA	1

*: Aculux recommended dimmers

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

0-10V Dimming (GZ1, EZ1, EZB drivers)

WALL DIMMERS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	Diva	DVTV	0-10V	1	<1
Lutron	Nova	NFTV	0-10V	1	<1
Lutron	Nova T	NTFTV	0-10V	1	<1

INTEGRATED CONTROL SYSTEMS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	GrafikEye QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVM2*	0-10V	1	<1
Lutron	LCP128	GRX-TVI*	0-10V	1	<1
Lutron	LCP128	GRX-TVM2*	0-10V	1	<1
Lutron	LP	GRX-TVM2*	0-10V	1	<1
Lutron	RadioRA2	LMJ-5T-DV-B	0-10V	1**	<1
Crestron	GreenLight	DIN-4DIMFLV4	0-10V	1	<1
Lutron	Energi Tripak	RMJ-5T-DV-B	0-10V	1	<1
Wattstopper	DLM	LMRC-211	0-10V	1	<1
Insteon	Ballast Dimmer	2475DA2	0-10V	1	<1

*: Aculux recommended dimmers
**: Not tested with -GZ1
+: Requires a separate relay module to turn luminaire on/off

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Aculux
CATALOG NUMBER	AX4 A 27LM 30K 90CRI 45D EZB MVOLT 4AC CS SF
TOTAL WATTS	25
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	20.83" x 13.75" x 7.2"
FINISH	Clear Specular
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	2700
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount adjustable downlight with one (1) LED lighting source, 2700 delivered lumens, 3000K color engine, 90+ CRI, 45° optic and integral driver. Downlight should operate on 120-277 voltage and be supplied with a 0-10v control option down to .01% and include a minimum 5-year warranty with a 50,000 hour anticipated life. Downlight to have clear specular finish. Downlight should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

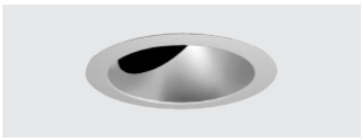
Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

ACULUX®

AX4 SERIES | 4" APERTURE

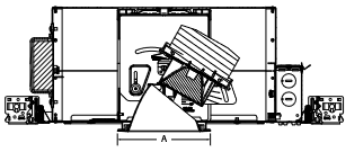
Adjustable Accent | 1200 – 3200 Lumens

TRIM STYLES



Angle-Cut Reflector

Bevel



A Dimension:
Self Flanged: 5.7"
Flangeless: 4.9"

FEATURES

SPOT ON! OPTICS

- Field Interchangeable TIR Optics in 9 distributions
- Accommodates up to 2 beam control lenses or filters

ACU-AIM™ PRECISION AIMING

- Precision geared hot-aiming provides 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in low aperture brightness

EXCEPTIONAL PERFORMANCE FROM 4-INCH APERTURE

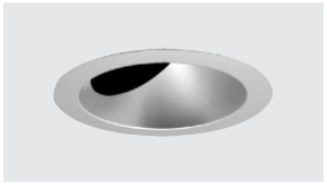
- Up to 3115 lumens, 27,000 CBCP Delivered!
- Exceptionally consistent color with < 2SDCM for Static White & Tunable White; <1SDCM for WarmDim
- Excellent color rendition with 95+ CRI | 90+ R9 Available
- WarmDim® option mimics halogen dimming (3000K-1800K)
- Tunable White CCT range of 5000K –2700K

PERFORMANCE

LUMEN PACKAGE	WATTS IN	DELIVERED LUMENS	EFFICACY (LPW)	MCBCP
Static White*				
12LM	9	1215	135	10407
17LM	13	1557	119	13342
22LM	19	2118	111	18145
27LM	25	2616	104	22415
32LM	33	3115	94	26685
WarmDim®				
08LM	16	736	46	14836
12LM	26	1174	45	14114
15LM	29	1433	49	11340
17LM	33	1589	48	12572
Tunable White				
12LM	19	1305	67	12640
17LM	28	1912	68	18519
22LM	38	2438	64	23616

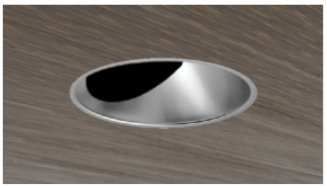
*Performance with 4AC trim at 30K | 80CRI (Static White), 30K | 90CRI (WarmDim) & 50K | 90CRI (Tunable White)
Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25°C

FLANGE STYLES



Self-Flanged

Flangeless (Gypsum)



Flangeless (Wood | Stone | Tile)

© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

ORDERING INFORMATION

EXAMPLE: AX4 A 27LM 30K 95CRI 24D FPC 120 ICAT 4ABV BD WHSF

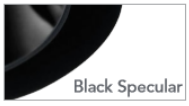
Housing Style	Lumens	CCT	CRI	Beam	Driver	Voltage[4]	Ratings	Options
AX4 A New Construction Adjustable	**Static White** 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens 27LM 2700 lumens 32LM[1] 3200 lumens	27K 2700K 30K 3000K 35K[2] 3500K 40K[2] 4000K	80CRI 90CRI 95CRI	12D 12° beam 20D 20° beam 24D 24° beam 30D 30° beam 35D 35° beam 40D 40° beam 45D 45° beam 50D 50° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 0-10V eldoLED | linear 1% min EZB 0-10V eldoLED | log <1% min EDXB eldoLED DMX | square <1% min EDAB eldoLED DALI 6 | log <1% min FPC Phase Cut Dimming | 1% min ECOD Lutron EcoSystem | 1% min	120 277 MVOLT (120-277)	(blank) Non-ICAT CP[5] Chicago Plenum ICAT[5] IC Rated, Air-tight	NLIGHT[6] nLight Dimming pack controls (Static White and WarmDim only) E6WT20R[7] Emergency 6W battery pack with remote test switch, T20 compliant
	WarmDim® 08LM 800 lumens 12LM 1200 lumens 15LM 1500 lumens 17LM 1700 lumens	WDIM HALR 3000K - 1800K	90CRI	10D[3] 10° beam 15D[3] 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50°x 20°	GZ1 0-10V | 1% min FPC Phase Cut Dimming | 1% min			
	Tunable White 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens	TUWH 5000K - 2700K	90CRI	15D 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 eldoLED 0-10V | linear 1% min EZB eldoLED 0-10V | log <1% min NLT[6] nLight nTune interface EDAB eldoLED DALI 6 | log <1% min EDABT8 eldoLED DALI 8 | log <1% min			

Trim	Reflector Finish	Flange Style	Trim Lens | Environment
Adjustable Reflector 4AC Angle Cut Reflector (0-45°) 4AC20 Shallow Cut Reflector (0-20°) 	W White Paint CD Clear Diffuse CS Clear Specular BS Black Specular WTD Wheat Diffuse	*Flanged* SF Self Flanged WHSF Self Flanged, White Painted Flange (not available with W finish) *Flangeless*[8] FM Flangeless	(blank) Open | Damp Location WET[9] Solite | Wet Location
Bevel 4ABV BD Bevel Adjustable (0-45°) 	**Bevel Finish & Flange Style** *Flanged* WHSF White, Flanged BLSF Black, Flanged *Flangeless*[8] WHFM White, Flangeless BLFM Black, Flangeless		(blank) Open | Damp WET Solite | Wet Location

Ceiling Installation	
Flanged	
(blank)	Ceiling Thickness < 0.875"
CTA4/125	Ceiling Thickness 0.875" - 1.25"
CTA4/163	Ceiling Thickness 1.25" - 1.625"
CTA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Gypsum)	
FMA4/087	Ceiling Thickness < 0.875"
FMA4/125	Ceiling Thickness 0.875" - 1.25"
FMA4/163	Ceiling Thickness 1.25" - 1.625"
FMA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Wood | Stone | Tile)[10]	
SFM4/087 (B,W)	Ceiling Thickness < 0.875"
SFM4/125 (B,W)	Ceiling Thickness 0.875" - 1.25"
SFM4/163 (B,W)	Ceiling Thickness 1.25" - 1.625"

© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

REFLECTOR FINISHES



BEVEL FINISHES

ORDERING NOTES

1. 32LM not available with ICAT and CP.
2. 35K available in 80CRI and 90CRI only. 40K available in 80CRI only. Contact factory for other CCT/CRI combinations.
3. For WDIM, 10D only available with 08LM and 12LM; 15D only available with 15LM and 17LM.
4. MVOLT standard on GZ1, EZ1, EZB, ECOD, EDXB, EDAB, EDABT8, NLT (unless NLIGHT). Must be 120 for FPC.
5. CP or ICAT not available with 17LM WDIM or 22LM TUWH
6. Must specify 120 or 277 volts for NLIGHT; MVOLT for NLT. NLIGHT only available with EZ1, EZB (for static white) or GZ1 (for warmDim). NLT not available with CP.
7. E6WT20R not available with WDIM, TUWH, EDXB, CP, ICAT, or NLIGHT.
8. Must specify FMA4 or SFM4 option.
9. WET not available with 4AC20.
10. Specify finish: B = Black, W = White.

ACCESSORIES

Beam Control Lenses & Filters

DIFF 300	Diffuse Spread lens
SOLITE 300	Solite Uniformity Lens
PRISM 300	Prismatic Lens
LSPREAD 300	Linear Spread Lens
HCLBL 300	Hexcell Louver
UVF 300	UV Filter Lens
DCCF 300 HAL4250	Daylight Blue Correction

Replacement Optics

Static White Optics

4AXOPT/12D	12° Beam
4AXOPT/20D	20° Beam
4AXOPT/24D	24° Beam
4AXOPT/30D	30° Beam
4AXOPT/35D	35° Beam
4AXOPT/40D	40° Beam
4AXOPT/45D	45° Beam
4AXOPT/50D	50° Beam
4AXOPT/55D	55° Beam
4AXOPT/50D20D	50°x20° Beam

WarmDim Optics

4AXWDOPT/10D	10° Beam
4AXWDOPT/15D	15° Beam
4AXWDOPT/20D	20° Beam
4AXWDOPT/24D	24° Beam
4AXWDOPT/35D	35° Beam
4AXWDOPT/45D	45° Beam
4AXWDOPT/55D	55° Beam
4AXWDOPT/50D20D	50°x20° Beam

Tunable White Optics

4AXTWOPT/15D	15° Beam
4AXTWOPT/20D	20° Beam
4AXTWOPT/24D	24° Beam
4AXTWOPT/35D	35° Beam
4AXTWOPT/45D	45° Beam
4AXTWOPT/55D	55° Beam
4AXTWOPT/50D20D	50°x20° Beam

Optional Installation Accessories

Bar Hangers

HB1	Juno Real Nail® 3 Bar Hangers
HB26	26" C-Channel Bar Hangers
HB50	50" C-Channel Bar Hangers
LB27	27" Linear Bar Hangers

Note: Fixture supplied with Pro-Vi™ Bar Hangers

Emergency Inverter

IIS 35 HE	Up to 35W Remote Mount Micro Inverter (30LM Excluded)

© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PRODUCT SPECIFICATIONS

FIELD INTERCHANGEABLE LED LIGHT ENGINE
- Future proof and easy to maintain-serviceable from below the ceiling

Static White:
- <2SDCMBinning
- 2700K|3000K|3500K|4000K CCT
- 80+CRI available for all CCTs
- 90+CRI available for 2700K,3000K,3500K
- 95+ CRI (>90 R9) available for 2700K, 3000K

WarmDim:
- Proprietary WarmDim technology mimics halogen,with CCT shifting from 3000K to 1800K when dimmed.
- <1SDCM Binning, 90+CRI

Tunable White:
- Tunable CCT range 5000K to 2700K
- <2 SDCM Binning, 90+ CRI

SPOT-ON! PRECISION OPTICS
- Field Interchangeable TIR Optics from 12° FWHM to 50° FWHM provide smooth, striation-free beams
- Patented self-adjusting optic holder accommodates up to 2 beam control lenses or filters (US Patent 8,950,911)
- UGR is zero for fixtures aimed at nadir with a cut-off equal to or less than 60°, per CIE 117-1996 Discomfort Glare in Interior Lighting. UGR FAQs

ACU-AIM™ PRECISION AIMING
- Precision Geared hot-aiming via Phillips screwdriver
- 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in maximum efficiency and low aperture brightness
- Numeric indicator marks allow contractor to pre-aim fixtures

HIGH QUALITY TRIMS
- Available with die cast bevels and spun aluminum reflectors.
- Available in Self Flanged and Flangeless
- Must Specify FMA4 for gypsum flangeless installation
- Must specify SFM4 for wood, stone, tile flangeless installation

FIELD REPLACEABLE DRIVER
- Accommodates 120-277V input and multiple control protocols down
- Dims without perceived flicker to <1% depending on driver specified
- Field replaceable without tools from below the ceiling
- >0.9 Power Factor

BUY AMERICAN ACT
- This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
- Please refer to www.acuitybrands.com/resources/buy-american for additional information.

WARRANTY & RATED LIFE
- LED is rated for >50,000 hours at 70% lumen maintenance
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

EMERGENCY BATTERY
- Provides a minimum of 700 lumens (4AC, 3000K, 80CRI) for minimum duration of 90 minutes.
- Accessible below ceiling for simple service; Self-Testing
- Supplied with Class-2 plenum rated remote test switch
- CEC T20 Compliant

NEW CONSTRUCTION MOUNTING
- Features patented (US Patent 8,038,113) Pro-VI™ bar hanger system offering compatible with wood stud and T-bar
- All fixtures also feature vertically adjustable mounting brackets (butterfly brackets)
- Centerline indicators on plaster frame and patented (US Patent 8,277,090) Tru-Line™ Platform featuring +/- ½" translation aids fixture alignment after installation, prior to finishing the ceiling.

JUNCTION BOX
- Rated for (4) No. 12 AWG 90°C through branch circuit conductors.
- Includes (6) ½", (1) ¾", (4) Non-metallic sheathed cable knock-outs.
- Push-in electrical connectors for field connections.

CODES & LABELS
- UL & cUL listed for through branch wiring, damp location
- Meets energy code Air Leakage requirements per ASTM E283
- ENERGY STAR® certified with select trims and housings
- Can be used to comply with Title 24, Part 6 with select trims and housings. Reference T24 JA-8 database for list of compliant housings and trims.
- ICAT Static White housings are rated for direct contact with insulation, including open and closed cell spray foam* with a maximum R-value of 7.2R/in. This allows use in ceiling cavities insulated up to R60.
- ICAT WarmDim and Tunable White housings are rated for direct contact with insulation, including open cell spray foam* with a maximum R-value of 3.8R/in. They are not suitable for use with closed cell spray foam. *Note: Options: "12LM WDIM", "ECOD", "EDXB", "NLT" & "NLIGHT" are excluded and not suitable for use with spray foam insulation.
- Union made

CEILING THICKNESS
- Accommodates ½" to 2" ceiling thickness

A+ CAPABLE LUMINAIRE
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning, when used with Acuity Brands controls products.
- All configurations of this luminaire are calibrated and tested to meet the Acuity Brand's specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications and testing, visit www.acuitybrands.com/aplus.

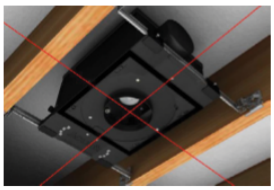
Spot On! Precision Optics

Smooth, striation-free beams with field-interchangeable TIR optics from 12° to 50°

Acu-Aim™ Precision Aiming

Precision geared hot-aiming is effortless. Centerbeam optics results in lower aperture brightness

Tru-Line™ Precision Installation

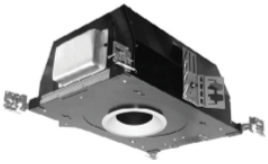


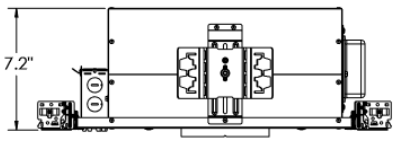
Pro-VI™ bar hangers, coupled with +/-1/2" aperture translation makes perfect installation achievable

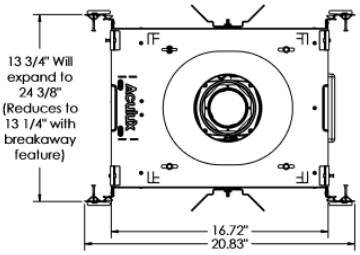
© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMENSIONS

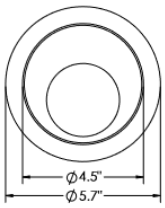
New Construction Adjustable (AX4 A)
ICAT/Non-ICAT: 12LM | 17LM | 22LM | 27LM
Non-ICAT: 32LM
Ceiling Cutout: 5-1/4" (refer to installation instructions for flangeless ceiling cutout)



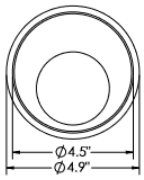




Reflector Trim (4AC & 4AC20)

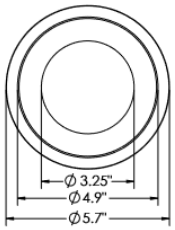


Flanged

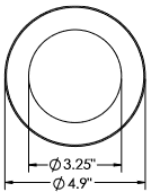


Flangeless

Bevel Trim (4ABV)



Flanged



Flangeless

ELECTRICAL SPECIFICATIONS

Static White

LUMEN PACKAGE	12LM		17LM		22LM		27LM		32LM	
Voltage	120	277	120	277	120	277	120	277	120	277
Input Watts	9.5	10.0	13.7	14.7	19.5	20.4	25.8	26.4	33.4	33.6
Input Current	0.08	0.04	0.11	0.06	0.16	0.08	0.22	0.10	0.28	0.13
Frequency	50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
Power Factor	0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

WarmDim

08LM		12LM		15LM		17LM	
120	277	120	277	120	277	120	277
16.1	16.5	25.6	25.9	28.9	29.0	32.8	32.9
0.14	0.06	0.21	0.10	0.24	0.11	0.27	0.12
50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

Tunable White

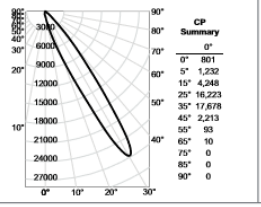
12LM		15LM		22LM	
120	277	120	277	120	277
18.2	19.5	27.2	28.0	36.9	37.5
0.15	0.08	0.23	0.11	0.31	0.14
50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.	

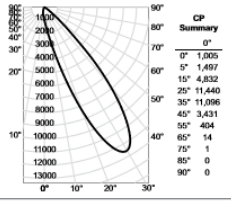
© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

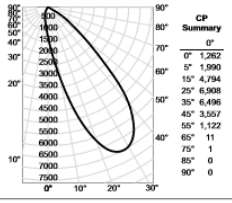
PHOTOMETRICS (@ 30° TILT) - 4AC

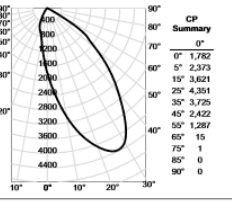
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4AC CS
Input Watts: 33.4, Delivered Lumens: 3146, LPW: 94.2, Test No: 20-421-23P198	Input Watts: 33.4, Delivered Lumens: 3062, LPW: 91.7, Test No: 20-421-25P198	Input Watts: 33.4, Delivered Lumens: 3087, LPW: 92.4, Test No: 20-421-27P198	Input Watts: 33.4, Delivered Lumens: 2886, LPW: 86.4, Test No: 20-421-30P198

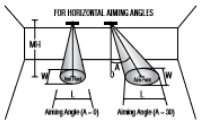




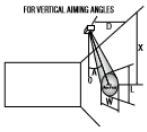




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0° MH	0° FC	0° L	0° W	30° FC	30° L	30° W	30° D	30° FC	30° X	30° L	30° W	45° FC	45° X	45° L	45° W
12D	26685	6	741	1.4	1.4	481	1.9	1.6	3	371	5.2	2.9	1.4	1048	3.0	1.4	1.0
		8	417	1.9	1.9	271	2.5	2.2	4	208	6.9	3.9	1.9	590	4.0	1.9	1.3
		10	267	2.3	2.3	173	3.1	2.7	5	133	8.7	4.9	2.3	377	5.0	2.4	1.6
		12	185	2.8	2.8	120	3.7	3.2	6	93	10.4	5.8	2.8	262	6.0	2.8	2.0
		14	136	3.3	3.3	88	4.4	3.8	7	68	12.1	6.8	3.3	193	7.0	3.3	2.3
24D	12566	4	785	1.7	1.7	510	2.4	2.0	2	393	3.5	4.1	1.7	1111	2.0	1.8	1.2
		6	349	2.6	2.6	227	3.5	3.0	3	175	5.2	6.1	2.6	494	3.0	2.7	1.9
		8	196	3.5	3.5	128	4.7	4.0	4	98	6.9	8.1	3.5	278	4.0	3.7	2.5
		10	126	4.4	4.4	82	5.9	5.0	5	63	8.7	10.2	4.4	178	5.0	4.6	3.1
		12	87	5.2	5.2	57	7.1	6.0	6	44	10.4	12.2	5.2	123	6.0	5.5	3.7
35D	7008	4	438	2.5	2.5	284	3.4	2.8	2	219	3.5	6.8	2.5	619	2.0	2.7	1.7
		6	195	3.7	3.7	126	5.1	4.2	3	97	5.2	10.3	3.7	275	3.0	4.1	2.6
		8	110	4.9	4.9	71	6.8	5.7	4	55	6.9	13.7	4.9	155	4.0	5.4	3.5
		10	70	6.1	6.1	46	8.4	7.1	5	35	8.7	17.1	6.1	99	5.0	6.8	4.3
		12	49	7.4	7.4	32	10.1	8.5	6	24	10.4	20.5	7.4	69	6.0	8.1	5.2
50D	4362	4	273	3.2	3.2	177	4.5	3.7	2	136	3.5	12.2	3.2	386	2.0	3.8	2.3
		6	121	4.8	4.8	79	6.7	5.5	3	61	5.2	18.3	4.8	171	3.0	5.7	3.4
		8	68	6.4	6.4	44	9.0	7.4	4	34	6.9	24.4	6.4	96	4.0	7.6	4.5
		10	44	8.0	8.0	28	11.2	9.2	5	22	8.7	30.5	8.0	62	5.0	9.5	5.6
		12	30	9.6	9.6	20	13.5	11.1	6	15	10.4	36.7	9.6	43	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

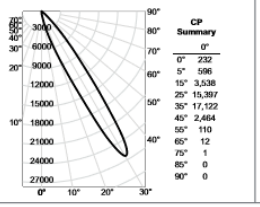
*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

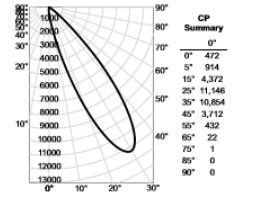
© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

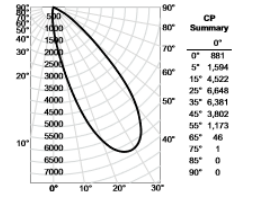
PHOTOMETRICS (@ 30° TILT) - 4ABV

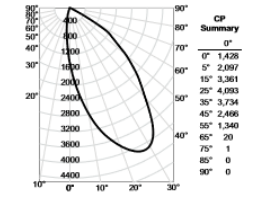
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4ABV BD
Input Watts: 33.4, Delivered Lumens: 2634, LPW: 78.9, Test No: 20-421-32P40	Input Watts: 33.4, Delivered Lumens: 2648, LPW: 79.3, Test No: 20-421-34P40	Input Watts: 33.4, Delivered Lumens: 2751, LPW: 82.4, Test No: 20-421-36P40	Input Watts: 33.4, Delivered Lumens: 2499, LPW: 74.8, Test No: 20-421-39P40

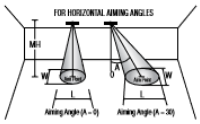




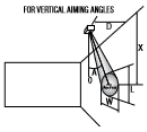




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0° MH	0° FC	0° L	0° W	30° FC	30° L	30° W	30° D	30° FC	30° X	30° L	30° W	45° FC	45° X	45° L	45° W
12D	26261	6	729	1.3	1.3	474	1.8	1.6	3	365	5.2	2.8	1.3	1032	3.0	1.4	1.0
		8	410	1.8	1.8	267	2.4	2.1	4	205	6.9	3.7	1.8	580	4.0	1.8	1.3
		10	263	2.2	2.2	171	3.0	2.6	5	131	8.7	4.7	2.2	371	5.0	2.3	1.6
		12	182	2.7	2.7	118	3.6	3.1	6	91	10.4	5.6	2.7	258	6.0	2.7	1.9
		14	134	3.1	3.1	87	4.2	3.6	7	67	12.1	6.5	3.1	189	7.0	3.2	2.2
24D	12278	4	767	1.7	1.7	498	2.3	2.0	2	384	3.5	4.0	1.7	1085	2.0	1.8	1.2
		6	341	2.6	2.6	222	3.5	3.0	3	171	5.2	6.0	2.6	482	3.0	2.7	1.8
		8	192	3.5	3.5	125	4.7	4.0	4	96	6.9	8.0	3.5	271	4.0	3.6	2.4
		10	123	4.3	4.3	80	5.9	5.0	5	61	8.7	10.1	4.3	174	5.0	4.5	3.1
		12	85	5.2	5.2	55	7.0	6.0	6	43	10.4	12.1	5.2	121	6.0	5.4	3.7
35D	6786	4	424	2.5	2.5	275	3.4	2.9	2	212	3.5	7.0	2.5	600	2.0	2.7	1.8
		6	189	3.7	3.7	122	5.1	4.3	3	94	5.2	10.4	3.7	267	3.0	4.1	2.6
		8	106	5.0	5.0	69	6.8	5.7	4	53	6.9	13.9	5.0	150	4.0	5.5	3.5
		10	68	6.2	6.2	44	8.5	7.1	5	34	8.7	17.4	6.2	96	5.0	6.8	4.4
		12	47	7.4	7.4	31	10.2	8.6	6	24	10.4	20.9	7.4	67	6.0	8.2	5.3
50D	4152	4	260	3.2	3.2	169	4.5	3.7	2	130	3.5	12.2	3.2	367	2.0	3.8	2.3
		6	115	4.8	4.8	75	6.7	5.5	3	58	5.2	18.3	4.8	163	3.0	5.7	3.4
		8	65	6.4	6.4	42	9.0	7.4	4	32	6.9	24.4	6.4	92	4.0	7.6	4.5
		10	42	8.0	8.0	27	11.2	9.2	5	21	8.7	30.5	8.0	59	5.0	9.5	5.6
		12	29	9.6	9.6	19	13.5	11.1	6	14	10.4	36.7	9.6	41	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMMER COMPATIBILITY

Phase Dimming (FPC) - Incandescent, Magnetic Low Voltage and Electronic Low Voltage Dimming

- Dimming range of 100% down to as low as 1% a minimum load of one fixture
- Dimming range and maximum rated load vary depending on dimmer type and model. See maximum load calculations below to identify max number of luminaires per dimmer.

Incandescent (INC) and Magnetic Low Voltage (MLV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 50%
(600/13W) X 0.5 = 23 Fixtures per Dimmer

Electronic Low Voltage (ELV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 75%
(600/13W) X 0.75 = 34 Fixtures per Dimmer

INCANDESCENT, MLV, ELV WALL DIMMERS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	Glyder	GLV*	MLV	2
Leviton	SureSlide	6633*	INC	2
Lutron	Diva	DVLV	MLV	6
Lutron	Diva	DV*	INC	2
Lutron	Skylark	SLV*	MLV	3
Lutron	RadioRA 2	RRD-6D*	INC	2
Lutron	RadioRA 2	RRD-10ND*	INC	2
Leviton	SureSlide	6613	MLV	5
Leviton	IllumaTech	IPL06-10Z*	INC	3
Lutron	Diva	DVCL	INC	3
Insteon	Keypad Dimmer	2334-232	INC	2
Insteon	Dimmer Switch	2477D*	INC	2
Control4	Forward Phase Dimmer	C4-FPD 120	INC	2
Lutron	Nova	NTELV	ELV	6
Lutron	Diva	DVELV*	ELV	2
Lutron	Lutron Maestro	MAELV*	ELV	5
Leviton	Vizia	VPE06-1LX	ELV	2
Leviton	Illumatech	IPE04*	ELV	5
Lutron	Lutron RadioRA2	RRD-6NA	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2
Lutron	RadioRA2	RRD-6NA*	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Sensor Switch	WPD	WPD*	INC	1
Leviton	Illmatech	IPM06-1LZ	MLV	3
Leviton	Illmatech	IPI06-1LZ	INC	2
Lutron	Diva	DVCL	INC	1
Leviton	SureSlide	6633*	INC	1
Leviton	SureSlide	6613*	MLV	1
Leviton	SureSlide	IPL06	INC	1
Control4	Forward phase dimmer	C4-FPD 120 FWD*	INC	1
Lutron	Diva	DVELV*	ELV	1
Lutron	Maestro	MAELV*	ELV	1
Lutron	Vive	MRF25-6ELV*	ELV	1
Lutron	Caseta	PD-5NE*	ELV	1
Leviton	Illumatech	IPE04	ELV	4
Lutron	Maestro	RRD-PRO REV	PHA	1
Control4	Phase Adaptive Dimmer	C4-APD 120*	PHA	1
Lutron	Maestro	RRD-PRO FWD*	PHA	1

INTEGRATED CONTROL SYSTEMS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	LP	LP-RPM-4U	INC	5
Lutron	LP	LP-RPM-4A*	PHA	2
Lutron	GrafikEye QS	QSGRJ-3P	PHA	2
Lutron	GrafikEye QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	2
Acuity	nLight nSP5PCD ELV	nSP5PCD*	ELV	4
Insteon	Micro Module Dimmer	2442-222*	INC	2
Control4	8 Ch Dimmer	C4-DIN-8DIM-E	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Acuity	nLight nSP5PCD ELV	nSP5PCD ELV*	ELV	1
Acuity	nLight nSP5PCD ELV	PCDM*	ELV	1
Acuity	Fresco LMPM	LMPM 2D 2L*	PHA	1
Lutron	LP	LP-RPM-4A *	PHA	1
Lutron	LP	LP-RPM-4U*	INC	1
Lutron	GrafikEye QS	Lutron PHPM-PA-120*	PHA	1
Lutron	GrafikEye QS	Lutron Grafik Eye QSGRJ-3P*	MLV	1
Lutron	HomeWorks QS	PHPM-PA-120*	PHA	1
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	1
Legrand	Wattstopper	LMRC-221-U*	PHA	1
Control4	8 Ch Dimmer	C4-DIN-8DIM-E*	PHA	1
Crestron	Phase Adaptive Dimmer	6501748*	PHA	1

*: Aculux recommended dimmers

© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

0-10V Dimming (GZ1, EZ1, EZB drivers)

WALL DIMMERS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	Diva	DVTV	0-10V	1	<1
Lutron	Nova	NFTV	0-10V	1	<1
Lutron	Nova T	NTFTV	0-10V	1	<1

INTEGRATED CONTROL SYSTEMS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	GrafikEye QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVM2*	0-10V	1	<1
Lutron	LCP128	GRX-TVI*	0-10V	1	<1
Lutron	LCP128	GRX-TVM2*	0-10V	1	<1
Lutron	LP	GRX-TVM2*	0-10V	1	<1
Lutron	RadioRA2	LMJ-5T-DV-B	0-10V	1**	<1
Crestron	GreenLight	DIN-4DIMFLV4	0-10V	1	<1
Lutron	Energi Tripak	RMJ-5T-DV-B	0-10V	1	<1
Wattstopper	DLM	LMRC-211	0-10V	1	<1
Insteon	Ballast Dimmer	2475DA2	0-10V	1	<1

*: Aculux recommended dimmers
**: Not tested with -GZ1
+: Requires a separate relay module to turn luminaire on/off

© 2017-2023 Acuity Brands Lighting, Inc. • One Lithonia Way, Conyers, GA 30012
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Aculux
CATALOG NUMBER	AX4 A 27LM 30K 90CRI 50D20D EZB MVOLT 4AC CS SF
TOTAL WATTS	25
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	4.5" x 4.5"
FINISH	Clear Specular
RATING	IP
LISTING	UL Damp Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	30k
CRI	90+
LUMEN OUTPUT	2516
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount adjustable downlight with one (1) LED lighting source, 2516 delivered lumens, 30k color engine, 90+ CRI, 50x20 optic and integral driver. Downlight should operate on 120-277 voltage and be supplied with a 0-10v control option down to .01% and include a minimum 5-year warranty with a 50,000 hour anticipated life. Downlight to have clear specular finish. Downlight should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

D64
AX4 A 27LM 30K 90CRI 50D20D
EZB MVOLT 4AC CS SF

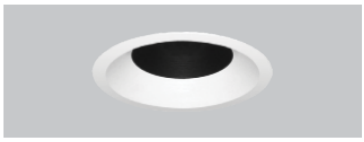
ACULUX®

AX4 SERIES | 4" APERTURE

Adjustable Accent | 1200 – 3200 Lumens

TRIM STYLES

Angle-Cut Reflector



Bevel

FEATURES

SPOT ON! OPTICS

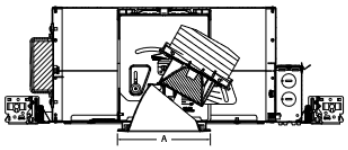
- Field Interchangeable TIR Optics in 9 distributions
- Accommodates up to 2 beam control lenses or filters

ACU-AIM™ PRECISION AIMING

- Precision geared hot-aiming provides 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in low aperture brightness

EXCEPTIONAL PERFORMANCE FROM 4-INCH APERTURE

- Up to 3115 lumens, 27,000 CBCP Delivered!
- Exceptionally consistent color with < 2SDCM for Static White & Tunable White; <1SDCM for WarmDim
- Excellent color rendition with 95+ CRI | 90+ R9 Available
- WarmDim® option mimics halogen dimming (3000K-1800K)
- Tunable White CCT range of 5000K –2700K



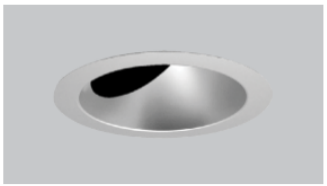
A Dimension:
Self Flanged: 5.7"
Flangeless: 4.9"

PERFORMANCE

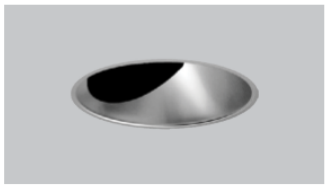
LUMEN PACKAGE	WATTS IN	DELIVERED LUMENS	EFFICACY (LPW)	MCBCP
Static White*				
12LM	9	1215	135	10407
17LM	13	1557	119	13342
22LM	19	2118	111	18145
27LM	25	2616	104	22415
32LM	33	3115	94	26685
WarmDim®				
08LM	16	736	46	14836
12LM	26	1174	45	14114
15LM	29	1433	49	11340
17LM	33	1589	48	12572
Tunable White				
12LM	19	1305	67	12640
17LM	28	1912	68	18519
22LM	38	2438	64	23616

*Performance with 4AC trim at 30K | 80CRI (Static White), 30K | 90CRI (WarmDim) & 50K | 90CRI (Tunable White)
Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25°C

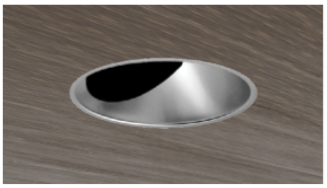
FLANGE STYLES



Self-Flanged



Flangeless (Gypsum)



Flangeless (Wood | Stone | Tile)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

D64
AX4 A 27LM 30K 90CRI 50D20D
EZB MVOLT 4AC CS SF

ACULUX

AX4 SERIES | 4" APERTURE

Adjustable Accent | 1200 – 3200 Lumens

ORDERING INFORMATION

EXAMPLE: AX4 A 27LM 30K 95CRI 24D FPC 120 ICAT 4ABV BD WHSF

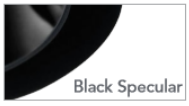
Housing Style	Lumens	CCT	CRI	Beam	Driver	Voltage[4]	Ratings	Options
AX4 A New Construction Adjustable	**Static White** 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens 27LM 2700 lumens 32LM[1] 3200 lumens	27K 2700K 30K 3000K 35K[2] 3500K 40K[2] 4000K	80CRI 90CRI 95CRI	12D 12° beam 20D 20° beam 24D 24° beam 30D 30° beam 35D 35° beam 40D 40° beam 45D 45° beam 50D 50° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 0-10V eldoLED | linear 1% min EZB 0-10V eldoLED | log <1% min EDXB eldoLED DMX | square <1% min EDAB eldoLED DALI 6 | log <1% min FPC Phase Cut Dimming | 1% min ECOD Lutron EcoSystem | 1% min	120 277 MVOLT (120-277)	(blank) Non-ICAT CP[5] Chicago Plenum ICAT[5] IC Rated, Air-tight	NLIGHT[6] nLight Dimming pack controls (Static White and WarmDim only) E6WT20R[7] Emergency 6W battery pack with remote test switch, T20 compliant
	WarmDim® 08LM 800 lumens 12LM 1200 lumens 15LM 1500 lumens 17LM 1700 lumens	WDIM HALR 3000K - 1800K	90CRI	10D[3] 10° beam 15D[3] 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50°x 20°	GZ1 0-10V | 1% min FPC Phase Cut Dimming | 1% min			
	Tunable White 12LM 1200 lumens 17LM 1700 lumens 22LM 2200 lumens	TUWH 5000K - 2700K	90CRI	15D 15° beam 20D 20° beam 24D 24° beam 35D 35° beam 45D 45° beam 55D 55° beam 50D20D 50° x 20°	GZ1 0-10V | 1% min EZ1 eldoLED 0-10V | linear 1% min EZB eldoLED 0-10V | log <1% min NLT[6] nLight nTune interface EDAB eldoLED DALI 6 | log <1% min EDABT8 eldoLED DALI 8 | log <1% min			

Trim	Reflector Finish	Flange Style	Trim Lens | Environment
Adjustable Reflector 4AC Angle Cut Reflector (0-45°) 4AC20 Shallow Cut Reflector (0-20°)	W White Paint CD Clear Diffuse CS Clear Specular BS Black Specular WTD Wheat Diffuse	*Flanged* SF Self Flanged WHSF Self Flanged, White Painted Flange (not available with W finish) *Flangeless*[8] FM Flangeless	(blank) Open | Damp Location WET[9] Solite | Wet Location
Bevel 4ABV BD Bevel Adjustable (0-45°)	**Bevel Finish & Flange Style** *Flanged* WHSF White, Flanged BLSF Black, Flanged *Flangeless*[8] WHFM White, Flangeless BLFM Black, Flangeless		(blank) Open | Damp WET Solite | Wet Location

Ceiling Installation	
Flanged	
(blank)	Ceiling Thickness < 0.875"
CTA4/125	Ceiling Thickness 0.875" - 1.25"
CTA4/163	Ceiling Thickness 1.25" - 1.625"
CTA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Gypsum)	
FMA4/087	Ceiling Thickness < 0.875"
FMA4/125	Ceiling Thickness 0.875" - 1.25"
FMA4/163	Ceiling Thickness 1.25" - 1.625"
FMA4/200	Ceiling Thickness 1.625" - 2"
Flangeless (Wood | Stone | Tile)[10]	
SFM4/087 (B,W)	Ceiling Thickness < 0.875"
SFM4/125 (B,W)	Ceiling Thickness 0.875" - 1.25"
SFM4/163 (B,W)	Ceiling Thickness 1.25" - 1.625"

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

REFLECTOR FINISHES



BEVEL FINISHES

ORDERING NOTES

1. 32LM not available with ICAT and CP.
2. 95CRI available on 27K and 30K only. Contact factory for other CCT/CRI combinations.
3. For WDIM, 10D only available with 08LM and 12LM; 15D only available with 15LM and 17LM.
4. MVOLT standard on GZ1, EZ1, EZB, ECOD, EDXB, EDAB, EDABT8, NLT (unless NLIGHT). Must be 120 for FPC.
5. CP or ICAT not available with 17LM WDIM or 22LM TUWH
6. Must specify 120 or 277 volts for NLIGHT; MVOLT for NLT. NLIGHT only available with EZ1, EZB (for static white) or GZ1 (for warmDim). NLT not available with CP.
7. E6WT20R not available with WDIM, TUWH, EDXB, CP, ICAT, or NLIGHT.
8. Must specify FMA4 or SFM4 option.
9. WET not available with 4AC20.
10. Specify finish: B = Black, W = White.

ACCESSORIES

Beam Control Lenses & Filters

DIFF 300	Diffuse Spread lens
SOLITE 300	Solite Uniformity Lens
PRISM 300	Prismatic Lens
LSPREAD 300	Linear Spread Lens
HCLBL 300	Hexcell Louver
UVF 300	UV Filter Lens
DCCF 300 HAL4250	Daylight Blue Correction

Replacement Optics

Static White Optics

4AXOPT/12D	12° Beam
4AXOPT/20D	20° Beam
4AXOPT/24D	24° Beam
4AXOPT/30D	30° Beam
4AXOPT/35D	35° Beam
4AXOPT/40D	40° Beam
4AXOPT/45D	45° Beam
4AXOPT/50D	50° Beam
4AXOPT/55D	55° Beam
4AXOPT/50D20D	50°x20° Beam

WarmDim Optics

4AXWDOPT/10D	10° Beam
4AXWDOPT/15D	15° Beam
4AXWDOPT/20D	20° Beam
4AXWDOPT/24D	24° Beam
4AXWDOPT/35D	35° Beam
4AXWDOPT/45D	45° Beam
4AXWDOPT/55D	55° Beam
4AXWDOPT/50D20D	50°x20° Beam

Tunable White Optics

4AXTWOPT/15D	15° Beam
4AXTWOPT/20D	20° Beam
4AXTWOPT/24D	24° Beam
4AXTWOPT/35D	35° Beam
4AXTWOPT/45D	45° Beam
4AXTWOPT/55D	55° Beam
4AXTWOPT/50D20D	50°x20° Beam

Optional Installation Accessories

Bar Hangers

HB1	Juno Real Nail® 3 Bar Hangers
HB26	26" C-Channel Bar Hangers
HB50	50" C-Channel Bar Hangers
LB27	27" Linear Bar Hangers

Note: Fixture supplied with Pro-Vi™ Bar Hangers

Emergency Inverter

IIS 35 HE	Up to 35W Remote Mount Micro Inverter (30LM Excluded)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PRODUCT SPECIFICATIONS

FIELD INTERCHANGEABLE LED LIGHT ENGINE
- Future proof and easy to maintain-serviceable from below the ceiling

Static White:
- <2SDCMBinning
- 2700K|3000K|3500K|4000K CCT
- 80 & 90CRI available for all CCTs
- 95+ CRI (>90 R9) available for 2700K, 3000K

WarmDim:
- Proprietary WarmDim technology mimics halogen,with CCT shifting from 3000K to 1800K when dimmed.
- <1SDCM Binning, 90+CRI

Tunable White:
- Tunable CCT range 5000K to 2700K
- <2 SDCM Binning, 90+ CRI

SPOT-ON! PRECISION OPTICS
- Field Interchangeable TIR Optics from 12° FWHM to 50° FWHM provide smooth, striation-free beams
- Patented self-adjusting optic holder accommodates up to 2 beam control lenses or filters (US Patent 8,950,911)
- UGR is zero for fixtures aimed at nadir with a cut-off equal to or less than 60°, per CIE 117-1996 Discomfort Glare in Interior Lighting. UGR FAQs

ACU-AIM™ PRECISION AIMING
- Precision Geared hot-aiming via Phillips screwdriver
- 370° horizontal, 45° vertical aiming
- Optimized center beam optics translates center of the beam through the center of the aperture resulting in maximum efficiency and low aperture brightness
- Numeric indicator marks allow contractor to pre-aim fixtures

HIGH QUALITY TRIMS
- Available with die cast bevels and spun aluminum reflectors.
- Available in Self Flanged and Flangeless
- Must Specify FMA4 for gypsum flangeless installation
- Must specify SFM4 for wood, stone, tile flangeless installation

FIELD REPLACEABLE DRIVER
- Accommodates 120-277V input and multiple control protocols down
- Dims without perceived flicker to <1% depending on driver specified
- Field replaceable without tools from below the ceiling
- >0.9 Power Factor

BUY AMERICAN ACT
- This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
- Please refer to www.acuitybrands.com/resources/buy-american for additional information.

WARRANTY & RATED LIFE
- LED is rated for >50,000 hours at 70% lumen maintenance
- 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

EMERGENCY BATTERY
- Provides a minimum of 700 lumens (4AC, 3000K, 80CRI) for minimum duration of 90 minutes.
- Accessible below ceiling for simple service; Self-Testing
- Supplied with Class-2 plenum rated remote test switch
- CEC T20 Compliant

NEW CONSTRUCTION MOUNTING
- Features patented (US Patent 8,038,113) Pro-VI™ bar hanger system offering compatible with wood stud and T-bar
- All fixtures also feature vertically adjustable mounting brackets (butterfly brackets)
- Centerline indicators on plaster frame and patented (US Patent 8,277,090) Tru-Line™ Platform featuring +/- ½" translation aids fixture alignment after installation, prior to finishing the ceiling.

JUNCTION BOX
- Rated for (4) No. 12 AWG 90°C through branch circuit conductors.
- Includes (6) ½", (1) ¾", (4) Non-metallic sheathed cable knock-outs.
- Push-in electrical connectors for field connections.

CODES & LABELS
- UL & cUL listed for through branch wiring, damp location
- Meets energy code Air Leakage requirements per ASTM E283
- ENERGY STAR® certified with select trims and housings
- Can be used to comply with Title 24, Part 6 with select trims and housings. Reference T24 JA-8 database for list of compliant housings and trims.
- ICAT Static White housings are rated for direct contact with insulation, including open and closed cell spray foam* with a maximum R-value of 7.2R/in. This allows use in ceiling cavities insulated up to R60.
- ICAT WarmDim and Tunable White housings are rated for direct contact with insulation, including open cell spray foam* with a maximum R-value of 3.8R/in. They are not suitable for use with closed cell spray foam. *Note: Options: "12LM WDIM", "ECOD", "EDXB", "NLT" & "NLIGHT" are excluded and not suitable for use with spray foam insulation.
- Union made

CEILING THICKNESS
- Accommodates ½" to 2" ceiling thickness

A+ CAPABLE LUMINAIRE
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning, when used with Acuity Brands controls products.
- All configurations of this luminaire are calibrated and tested to meet the Acuity Brand's specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications and testing, visit www.acuitybrands.com/aplus.

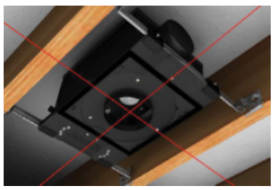
Spot On! Precision Optics

Smooth, striation-free beams with field-interchangeable TIR optics from 12° to 50°

Acu-Aim™ Precision Aiming

Precision geared hot-aiming is effortless. Centerbeam optics results in lower aperture brightness

Tru-Line™ Precision Installation

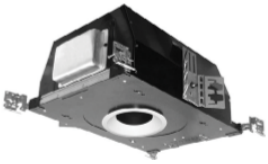


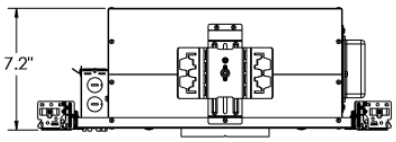
Pro-VI™ bar hangers, coupled with +/-1/2" aperture translation makes perfect installation achievable

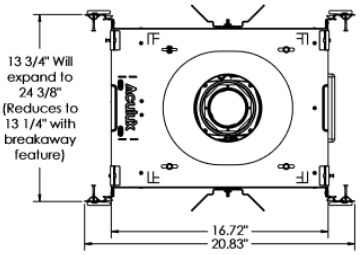
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMENSIONS

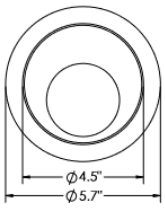
New Construction Adjustable (AX4 A)
ICAT/Non-ICAT: 12LM | 17LM | 22LM | 27LM
Non-ICAT: 32LM
Ceiling Cutout: 5-1/4" (refer to installation instructions for flangeless ceiling cutout)



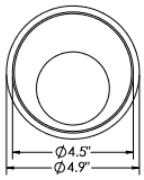




Reflector Trim (4AC & 4AC20)

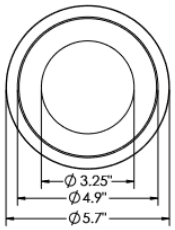


Flanged

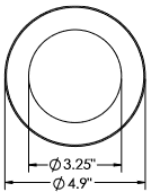


Flangeless

Bevel Trim (4ABV)



Flanged



Flangeless

ELECTRICAL SPECIFICATIONS

Static White

LUMEN PACKAGE	12LM		17LM		22LM		27LM		32LM	
Voltage	120	277	120	277	120	277	120	277	120	277
Input Watts	9.5	10.0	13.7	14.7	19.5	20.4	25.8	26.4	33.4	33.6
Input Current	0.08	0.04	0.11	0.06	0.16	0.08	0.22	0.10	0.28	0.13
Frequency	50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
Power Factor	0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

WarmDim

08LM		12LM		15LM		17LM	
120	277	120	277	120	277	120	277
16.1	16.5	25.6	25.9	28.9	29.0	32.8	32.9
0.14	0.06	0.21	0.10	0.24	0.11	0.27	0.12
50/60 Hz		50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.		0.9 MIN.	

Tunable White

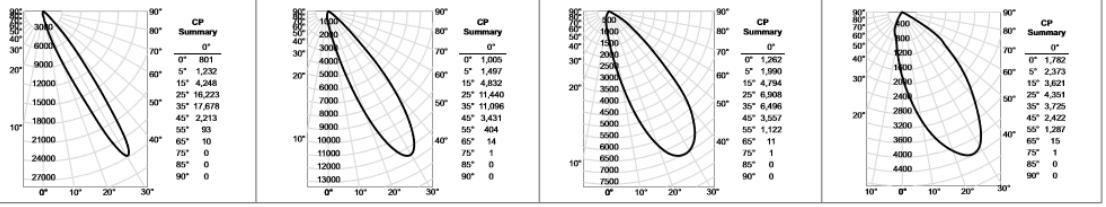
12LM		15LM		22LM	
120	277	120	277	120	277
18.2	19.5	27.2	28.0	36.9	37.5
0.15	0.08	0.23	0.11	0.31	0.14
50/60 Hz		50/60 Hz		50/60 Hz	
0.9 MIN.		0.9 MIN.		0.9 MIN.	

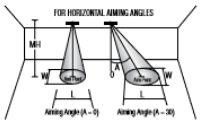
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

PHOTOMETRICS (@ 30° TILT) - 4AC

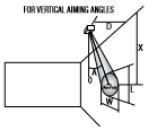
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4AC CS	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4AC CS
Input Watts: 33.4, Delivered Lumens: 3146, LPW: 94.2, Test No: 20-421-23P198	Input Watts: 33.4, Delivered Lumens: 3062, LPW: 91.7, Test No: 20-421-25P198	Input Watts: 33.4, Delivered Lumens: 3087, LPW: 92.4, Test No: 20-421-27P198	Input Watts: 33.4, Delivered Lumens: 2886, LPW: 86.4, Test No: 20-421-30P198





Horizontal Aiming Angles



Vertical Aiming Angles

Measured
32LM | 30K | 80 CRI

Beam Spread	CBCP	0°				30°			30°					45°			
		MH	FC	L	W	FC	L	W	D	FC	X	L	W	FC	X	L	W
12D	26685	6	741	1.4	1.4	481	1.9	1.6	3	371	5.2	2.9	1.4	1048	3.0	1.4	1.0
		8	417	1.9	1.9	271	2.5	2.2	4	208	6.9	3.9	1.9	590	4.0	1.9	1.3
		10	267	2.3	2.3	173	3.1	2.7	5	133	8.7	4.9	2.3	377	5.0	2.4	1.6
		12	185	2.8	2.8	120	3.7	3.2	6	93	10.4	5.8	2.8	262	6.0	2.8	2.0
		14	136	3.3	3.3	88	4.4	3.8	7	68	12.1	6.8	3.3	193	7.0	3.3	2.3
24D	12566	4	785	1.7	1.7	510	2.4	2.0	2	393	3.5	4.1	1.7	1111	2.0	1.8	1.2
		6	349	2.6	2.6	227	3.5	3.0	3	175	5.2	6.1	2.6	494	3.0	2.7	1.9
		8	196	3.5	3.5	128	4.7	4.0	4	98	6.9	8.1	3.5	278	4.0	3.7	2.5
		10	126	4.4	4.4	82	5.9	5.0	5	63	8.7	10.2	4.4	178	5.0	4.6	3.1
		12	87	5.2	5.2	57	7.1	6.0	6	44	10.4	12.2	5.2	123	6.0	5.5	3.7
35D	7008	4	438	2.5	2.5	284	3.4	2.8	2	219	3.5	6.8	2.5	619	2.0	2.7	1.7
		6	195	3.7	3.7	126	5.1	4.2	3	97	5.2	10.3	3.7	275	3.0	4.1	2.6
		8	110	4.9	4.9	71	6.8	5.7	4	55	6.9	13.7	4.9	155	4.0	5.4	3.5
		10	70	6.1	6.1	46	8.4	7.1	5	35	8.7	17.1	6.1	99	5.0	6.8	4.3
		12	49	7.4	7.4	32	10.1	8.5	6	24	10.4	20.5	7.4	69	6.0	8.1	5.2
50D	4362	4	273	3.2	3.2	177	4.5	3.7	2	136	3.5	12.2	3.2	386	2.0	3.8	2.3
		6	121	4.8	4.8	79	6.7	5.5	3	61	5.2	18.3	4.8	171	3.0	5.7	3.4
		8	68	6.4	6.4	44	9.0	7.4	4	34	6.9	24.4	6.4	96	4.0	7.6	4.5
		10	44	8.0	8.0	28	11.2	9.2	5	22	8.7	30.5	8.0	62	5.0	9.5	5.6
		12	30	9.6	9.6	20	13.5	11.1	6	15	10.4	36.7	9.6	43	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

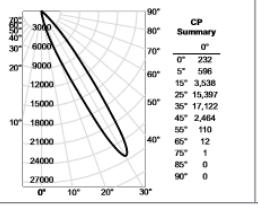
*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

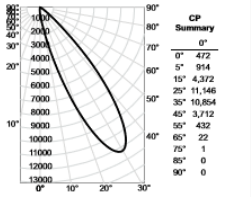
© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

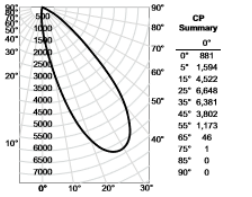
PHOTOMETRICS (@ 30° TILT) - 4ABV

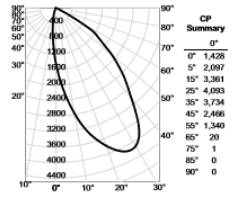
Tested in accordance to IESNA LM79

12 Degree Beam	24 Degree Beam	35 Degree Beam	50 Degree Beam
AX4 A 32LM 30K 80CRI 12D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 24D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 35D EZ1 MVOLT 4ABV BD	AX4 A 32LM 30K 80CRI 50D EZ1 MVOLT 4ABV BD
Input Watts: 33.4, Delivered Lumens: 2634, LPW: 78.9, Test No: 20-421-32P40	Input Watts: 33.4, Delivered Lumens: 2648, LPW: 79.3, Test No: 20-421-34P40	Input Watts: 33.4, Delivered Lumens: 2751, LPW: 82.4, Test No: 20-421-36P40	Input Watts: 33.4, Delivered Lumens: 2499, LPW: 74.8, Test No: 20-421-39P40

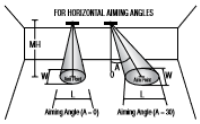




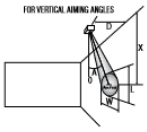




Measured
32LM | 30K | 80 CRI



Horizontal Aiming Angles



Vertical Aiming Angles

Beam Spread	CBCP	0° MH	0° FC	0° L	0° W	30° FC	30° L	30° W	30° D	30° FC	30° X	30° L	30° W	45° FC	45° X	45° L	45° W
12D	26261	6	729	1.3	1.3	474	1.8	1.6	3	365	5.2	2.8	1.3	1032	3.0	1.4	1.0
		8	410	1.8	1.8	267	2.4	2.1	4	205	6.9	3.7	1.8	580	4.0	1.8	1.3
		10	263	2.2	2.2	171	3.0	2.6	5	131	8.7	4.7	2.2	371	5.0	2.3	1.6
		12	182	2.7	2.7	118	3.6	3.1	6	91	10.4	5.6	2.7	258	6.0	2.7	1.9
		14	134	3.1	3.1	87	4.2	3.6	7	67	12.1	6.5	3.1	189	7.0	3.2	2.2
24D	12278	4	767	1.7	1.7	498	2.3	2.0	2	384	3.5	4.0	1.7	1085	2.0	1.8	1.2
		6	341	2.6	2.6	222	3.5	3.0	3	171	5.2	6.0	2.6	482	3.0	2.7	1.8
		8	192	3.5	3.5	125	4.7	4.0	4	96	6.9	8.0	3.5	271	4.0	3.6	2.4
		10	123	4.3	4.3	80	5.9	5.0	5	61	8.7	10.1	4.3	174	5.0	4.5	3.1
		12	85	5.2	5.2	55	7.0	6.0	6	43	10.4	12.1	5.2	121	6.0	5.4	3.7
35D	6786	4	424	2.5	2.5	275	3.4	2.9	2	212	3.5	7.0	2.5	600	2.0	2.7	1.8
		6	189	3.7	3.7	122	5.1	4.3	3	94	5.2	10.4	3.7	267	3.0	4.1	2.6
		8	106	5.0	5.0	69	6.8	5.7	4	53	6.9	13.9	5.0	150	4.0	5.5	3.5
		10	68	6.2	6.2	44	8.5	7.1	5	34	8.7	17.4	6.2	96	5.0	6.8	4.4
		12	47	7.4	7.4	31	10.2	8.6	6	24	10.4	20.9	7.4	67	6.0	8.2	5.3
50D	4152	4	260	3.2	3.2	169	4.5	3.7	2	130	3.5	12.2	3.2	367	2.0	3.8	2.3
		6	115	4.8	4.8	75	6.7	5.5	3	58	5.2	18.3	4.8	163	3.0	5.7	3.4
		8	65	6.4	6.4	42	9.0	7.4	4	32	6.9	24.4	6.4	92	4.0	7.6	4.5
		10	42	8.0	8.0	27	11.2	9.2	5	21	8.7	30.5	8.0	59	5.0	9.5	5.6
		12	29	9.6	9.6	19	13.5	11.1	6	14	10.4	36.7	9.6	41	6.0	11.4	6.8

In vertical aiming applications, aim point (X) is determined by dividing distance from the wall (D) by the tangent of the desired aim angle (A) (0.5774 for 30°, 1.0 for 45°).
CBCP • Centerbeam candlepower FC • Footcandles at beam center (aim point)

LUMEN | CBCP MULTIPLIERS

CCT	80+ CRI	90+ CRI	95+ CRI
2700K	0.95	0.83	0.68
3000K	1.00	0.87	0.73
3500K	1.02	0.89	-
4000K	1.04	-	-

12LM	17LM	22LM	27LM	32LM
0.39	0.50	0.68	0.84	1.0

*Refer to website for additional photometry (alternate trims, CCT/CRI, lumen packages)

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

DIMMER COMPATIBILITY

Phase Dimming (FPC) - Incandescent, Magnetic Low Voltage and Electronic Low Voltage Dimming

- Dimming range of 100% down to as low as 1% a minimum load of one fixture
- Dimming range and maximum rated load vary depending on dimmer type and model. See maximum load calculations below to identify max number of luminaires per dimmer.

Incandescent (INC) and Magnetic Low Voltage (MLV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 50%
(600/13W) X 0.5 = 23 Fixtures per Dimmer

Electronic Low Voltage (ELV)
Example: Fixture Rating = 13W; Dimmer Rating = 600W
Equivalent Incandescent Load (EIL) = 75%
(600/13W) X 0.75 = 34 Fixtures per Dimmer

INCANDESCENT, MLV, ELV WALL DIMMERS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	Glyder	GLV*	MLV	2
Leviton	SureSlide	6633*	INC	2
Lutron	Diva	DVLV	MLV	6
Lutron	Diva	DV*	INC	2
Lutron	Skylark	SLV*	MLV	3
Lutron	RadioRA 2	RRD-6D*	INC	2
Lutron	RadioRA 2	RRD-10ND*	INC	2
Leviton	SureSlide	6613	MLV	5
Leviton	IllumaTech	IPL06-10Z*	INC	3
Lutron	Diva	DVCL	INC	3
Insteon	Keypad Dimmer	2334-232	INC	2
Insteon	Dimmer Switch	2477D*	INC	2
Control4	Forward Phase Dimmer	C4-FPD 120	INC	2
Lutron	Nova	NTELV	ELV	6
Lutron	Diva	DVELV*	ELV	2
Lutron	Lutron Maestro	MAELV*	ELV	5
Leviton	Vizia	VPE06-1LX	ELV	2
Leviton	Illumatech	IPE04*	ELV	5
Lutron	Lutron RadioRA2	RRD-6NA	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2
Lutron	RadioRA2	RRD-6NA*	PHA	2
Control4	Adaptive Phase Dimmer	C4-APD 120	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Sensor Switch	WPD	WPD*	INC	1
Leviton	Illmatech	IPM06-1LZ	MLV	3
Leviton	Illmatech	IPI06-1LZ	INC	2
Lutron	Diva	DVCL	INC	1
Leviton	SureSlide	6633*	INC	1
Leviton	SureSlide	6613*	MLV	1
Leviton	SureSlide	IPL06	INC	1
Control4	Forward phase dimmer	C4-FPD 120 FWD*	INC	1
Lutron	Diva	DVELV*	ELV	1
Lutron	Maestro	MAELV*	ELV	1
Lutron	Vive	MRF25-6ELV*	ELV	1
Lutron	Caseta	PD-5NE*	ELV	1
Leviton	Illumatech	IPE04	ELV	4
Lutron	Maestro	RRD-PRO REV	PHA	1
Control4	Phase Adaptive Dimmer	C4-APD 120*	PHA	1
Lutron	Maestro	RRD-PRO FWD*	PHA	1

INTEGRATED CONTROL SYSTEMS

Static White

Manf.	Product Family	Series	Type	Min Light(%)
Lutron	LP	LP-RPM-4U	INC	5
Lutron	LP	LP-RPM-4A*	PHA	2
Lutron	GrafikEye QS	QSGRJ-3P	PHA	2
Lutron	GrafikEye QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	PHPM-PA-120	PHA	2
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	2
Acuity	nLight nSP5PCD ELV	nSP5PCD*	ELV	4
Insteon	Micro Module Dimmer	2442-222*	INC	2
Control4	8 Ch Dimmer	C4-DIN-8DIM-E	PHA	2

WarmDim®

Manf.	Product Family	Series	Type	Min Light(%)
Acuity	nLight nSP5PCD ELV	nSP5PCD ELV*	ELV	1
Acuity	nLight nSP5PCD ELV	PCDM*	ELV	1
Acuity	Fresco LMPM	LMPM 2D 2L*	PHA	1
Lutron	LP	LP-RPM-4A *	PHA	1
Lutron	LP	LP-RPM-4U*	INC	1
Lutron	GrafikEye QS	Lutron PHPM-PA-120*	PHA	1
Lutron	GrafikEye QS	Lutron Grafik Eye QSGRJ-3P*	MLV	1
Lutron	HomeWorks QS	PHPM-PA-120*	PHA	1
Lutron	HomeWorks QS	HW-RPM-4A*	PHA	1
Legrand	Wattstopper	LMRC-221-U*	PHA	1
Control4	8 Ch Dimmer	C4-DIN-8DIM-E*	PHA	1
Crestron	Phase Adaptive Dimmer	6501748*	PHA	1

*: Aculux recommended dimmers

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

0-10V Dimming (GZ1, EZ1, EZB drivers)

WALL DIMMERS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	Diva	DVTV	0-10V	1	<1
Lutron	Nova	NFTV	0-10V	1	<1
Lutron	Nova T	NTFTV	0-10V	1	<1

INTEGRATED CONTROL SYSTEMS

Manf.	Product Family	Series	Type	-EZ1/-GZ1 Min. Light (%)	-EZB Min. Light (%)
Lutron	GrafikEye QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVI*	0-10V	1	<1
Lutron	HomeWorks QS	GRX-TVM2*	0-10V	1	<1
Lutron	LCP128	GRX-TVI*	0-10V	1	<1
Lutron	LCP128	GRX-TVM2*	0-10V	1	<1
Lutron	LP	GRX-TVM2*	0-10V	1	<1
Lutron	RadioRA2	LMJ-5T-DV-B	0-10V	1**	<1
Crestron	GreenLight	DIN-4DIMFLV4	0-10V	1	<1
Lutron	Energi Tripak	RMJ-5T-DV-B	0-10V	1	<1
Wattstopper	DLM	LMRC-211	0-10V	1	<1
Insteon	Ballast Dimmer	2475DA2	0-10V	1	<1

*: Aculux recommended dimmers
**: Not tested with -GZ1
+: Requires a separate relay module to turn luminaire on/off

© 2017-2025 Acuity Brands Lighting, Inc. • 1 Acuity Way, Decatur, GA 30035
www.aculuxlighting.com • Phone: 1-800-705-SERV (7378) Specifications subject to change without notice.

EQUIPMENT

MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	LDN4-30/10 L04AR-LS-MVOLT EZ1
TOTAL WATTS	10.58
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	11 3/16" x 9 7/16" x 5 11/16"
FINISH	Specular
RATING	IP
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	1045
ANTICIPATED LIFE	60,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount fixed downlight with one (1) LED lighting source, 1045 delivered lumens, 3000K color engine, 80+ CRI, 55° optic and integral driver. Downlight should operate on MVOLT voltage and be supplied with a 0-10v control option with a 60,000 hour anticipated life. Downlight to have specular finish. Downlight should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

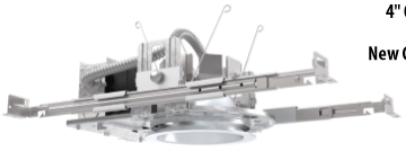
Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

D71

Catalog Number	LDN4-30/10 L04AR-LS-MVOLT EZ1
Notes	
Type	

LDN4 STATIC WHITE

4" Open and Wallwash LED
Non-IC
New Construction Downlight



Open Trim

Wallwash Trim

FEATURES & SPECIFICATIONS

INTENDED USE — Typical applications include corridors, lobbies, conference rooms and private offices.

CONSTRUCTION — Galvanized steel mounting/plaster frame; galvanized steel junction box with bottom-hinged access covers and spring latches. Reflectors are retained by torsion springs.

Vertically adjustable mounting brackets with commercial bar hangers provide 3-3/4" total adjustment.

Two combination 1/2"-3/4" and four 1/2" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out). No. 12 AWG conductors, rated for 90°C.

Accommodates 12"-24" joist spacing.

Passive cooling thermal management for 25°C standard; high ambient (40°C) option available. Light engine and drivers are accessible from above or below ceiling.

Max ceiling thickness 1-1/2".

OPTICS — LEDs are binned to a 3-step MacAdam Ellipse; 80 CRI minimum. 90 CRI optional.

LED light source concealed with diffusing optical lens.

General illumination lighting with 1.0 S/MH and 55° cutoff to source and source image.

Self-flanged anodized reflectors in specular, semi-specular, or matte diffuse finishes. Also available in white and black painted reflectors.

UGR — UGR is zero for fixtures aimed at nadir with a cut-off equeal to or less than 60deg per CIE 117-1996 Discomfort Galre in Interior Lighting. UGR FAQs

ELECTRICAL — Multi-volt (120-277V, 50/60Hz) 0-10V dimming drivers mounted to junction box, 10% or 1% minimum dimming level available.

0-10V dimming fixture requires two (2) additional low-voltage wires to be pulled.

LUMEN MAINTENANCE — 70% lumen maintenance at 60,000 hours.

LISTINGS — Certified to US and Canadian safety standards. Wet location standard (covered ceiling). IP55 rated. Drivers are ROHS compliant

GOVERNMENT PROCUREMENT — BAA – Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA – Build America Buy America: Product with the BAA option also qualifies as produced in the United States under the definitions of the Build America, Buy America Act.

Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

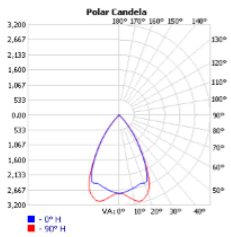
Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

PERFORMANCE DATA

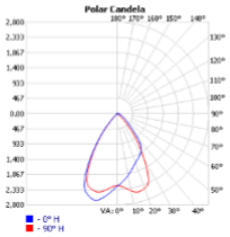
LDN4			
Nominal	**Lumens**	**Wattage**	**Lm/W**
500	523.6	5.74	91.2
750	751.1	8.6	87.3
1000	1045	10.58	98.8
1500	1512	17.5	86.4
2000	2006	22.12	90.7
2500	2551	26.1	97.7
3000	3007	32.1	93.7
4000	4212	43	98.0

Notes
Tested in accordance with IESNA LM-79-08
Tested to current IES and NEMA standards under stabilized laboratory conditions
Based on LDN4 AR LSS 35K 80CRI

DISTRIBUTIONS



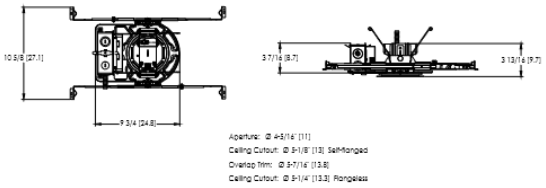
Open



Wallwash

DIMENSIONS

LDN4 500-2000 Lumens



See page 4 for other fixture dimensions

LDN4

D71
LDN4-30/10 L04AR-LS-MVOLT EZ1

Design Select options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LDN4 35/15 L04 AR LSS MVOLT EZ1

LDN4							
Series	**Color temperature**	**Lumens ‡**		**Trim Style**	**Trim Color**	**Trim Finish**	**Flange Color ‡**
LDN4 4" round	27/ 2700K	05 500 lumens	20 2000 lumens	L04 Downlight	AR Clear	LSS Semi-specular	TRW White painted flange
	30/ 3000K	07 750 lumens	25 2500 lumens	LW4 Wallwash	WR ‡ White	LD Matte diffuse	TRBL Black painted flange
	35/ 3500K	10 1000 lumens	30 3000 lumens		BR ‡ Black	LS Specular	FRALTBD RAL painted flange only
	40/ 4000K	15 1500 lumens	40 4000 lumens		TRALTBD ‡ RAL painted trim		FCPC Custom painted flange only
	50/ 5000K				TCPC ‡ Custom painted trim		

Voltage	**Driver**	**Emergency ‡**	**Control Input ‡**
MVOLT Multi-volt	GZ10 0-10V driver dims to 10%	(blank) No emergency option	(blank) No control option
120 120V	GZ1 0-10V driver dims to 1%	EL Emergency battery pack with integral test switch. 10W Constant Power, Not Certified in CA Title 20 MAEDBS	NPP16D nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).
277 277V	D10 Minimum dimming 10% driver for use with SSAIR	ELR Emergency battery pack with remote test switch. 10W Constant Power, Not Certified in CA Title 20 MAEDBS	NPP16DER nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.
347 ‡ 347V	D1 Minimum dimming 1% driver for use with SSAIR	ELSD Emergency battery pack with self-diagnostics, 10W Constant Power, integral test switch. Not Certified in CA Title 20 MAEDBS	N80 nLight™ Lumen Compensation
	EZ1 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1%	ELRSD Emergency battery pack with self-diagnostics, 10W Constant Power, remote test switch. Not Certified in CA Title 20 MAEDBS	SSAIR Wireless standalone embedded control by SensorSwitch
	EDAB eldoLED DALI SOLDRIVE dim to dark	E10WCP Emergency battery pack, 10W Constant Power with integral test switch. Certified in CA Title 20 MAEDBS	NPS80EZ nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1).
		E10WCPR Emergency battery pack, 10W Constant Power with remote test switch. Certified in CA Title 20 MAEDBS	NPS80EZER nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1). ER controls fixtures on emergency circuit.
		E10WRSTAR Emergency battery pack, 10W with remote test switch and Iota STAR technology	NLTAIR2 nLight® Air enabled
			NLTAIRER2 nLight® AIR Dimming Pack Wireless Controls. Controls fixtures on emergency circuit, not available with battery pack options
			NLTAIREM2 nLight® AIR Dimming Pack Wireless Controls. UL924 Emergency Operation, via power interrupt detection. Available with battery pack options.

Options	
HAO ‡	High ambient option (40°C)
CP ‡	Chicago Plenum
RRL___	RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature. Available only in RRLA, RRLB, RRLAE, and RRLC12S.
BAA	Buy America(n) Act and/or Build America Buy America Qualified
90CRI	High CRI (90+)
SF ‡	Single fuse

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

(Maximum order quantity for design select lead times is 160.)

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
Lumen Packages	Overall height varies based on lumen package, refer to dimensional charts on page 4
WR, BR	Not available with finish (LSS, LD, LS)
TRALTBD, FRALTBD	RALTBD for pricing only. Replace with applicable RAL number and finish when ready to order. See the RAL BROCHURE for available color options. Not available with TCPC or FCPC
TRW, TRBL	Available with clear (AR) trim color only
TCPC, FCPC	CPC options for pricing only. Custom color chip needs to be sent in to your Customer Resolution specialist before order can be processed. Click HERE for more details. Not available with TRAL or FRAL
347	Not available with emergency options
All Emergency	12.5" of plenum depth or top access required for battery pack maintenance.
NPP16D, NPP16DER	Not available with MVOLT. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
SF	Must specify 120 or 277 volt
N80	Fixture begins at 80% light level. Must be specified with NPS80EZ or NPS80EZ ER. Only available with EZ10 and EZ1 drivers.
NPP16D, NPP16DER, NPPS80EZ, NPS80EZER	Specify voltage. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
NLTAIR2, NLTAIRER2, NLATAIREM2	Not available with CP, NPS80EZ, NPS80EZER, NPP16D, NPP16DER or N80 options. Not recommended for metal ceiling installations.
NLTAIR2	When combined with EZ1 or EZ10 drivers, can be used as a normal power
SSAIR	Must specify D10 or D1 driver. Not available with nLight options. Not available with CP. Not recommended for metal ceiling installation. Not for use with emergency backup power systems other than battery packs.
HAO	Fixture height is 5-11/16" for all lumen packages with HAO.
CP	Must specify voltage for 3000lm. Not available with emergency battery pack option.
E10WRSTAR	Not available with wet location, EC1, EC6, QDS, CP, 347V, NPS80EZ ER, NLTAIRER2, NLTAIREM2, ALO3 & ALO4 w/DALI, OR 2000-4500 lumens w/SSAIR. Top access installation or 17.5" plenum clearance required for roomside installation. Not available with integral test switch.

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

Accessories: *Order as separate catalog number.*	
EACISSM 375	Compact interruptible emergency AC power system
EACISSM 125	Compact interruptible emergency AC power system
GRA46 JZ	Oversized trim ring with 6" outside diameter
SCA4	Sloped Ceiling Adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA4 10D.

Emergency Battery Pack Options - Field Installable

Battery Model Number	Wattage	Runtime (Minutes)	Lumen Output* @ 120 Lumens/Watt	Other
ILB CP07 2H A	7W	120	840	Storm Shelter/ 2-hour Runtime
ILB CP10 A	10W	90	1200	
ILBLP CP10 HE SD A+	10W	90	1200	Title 20, Self Diagnostic
ILBLP CP15 HE SD A+	15W	90	1800	Title 20, Self Diagnostic
ILB CP20 HE A	20W	90	2400	Title 20
ILB CP20 HE SD A	20W	90	2400	Title 20, Self Diagnostic
ILBHI CP10 HE SD A+	10W	90	1200	347-480V AC Input, Title 20, Self Diagnostic
ILBHI CP15 HE SD A+	15W	90	1800	347-480V AC Input, Title 20, Self Diagnostic

All the above are UL 924 Listed products that are certified for field install external/remote to the fixture.
*Minimum delivered lumen output to assist in product selection for increased fixture mounting height.
The CP10 delivered emergency illuminations outperforms legacy 1400 lumen fluorescent emergency ballasts.
Please contact us at techsupport@iotaengineering.com for any Emergency Battery related questions.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

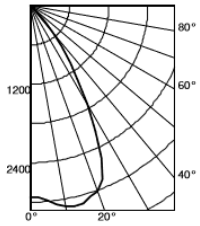
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

LDN4

PHOTOMETRY

Distribution Curve | **Distribution Data** | **Output Data** | **Illuminance Data at 30" Above Floor for a Single Luminaire**

LDN4 35/30 LO4AR, input watts: 32.1, delivered lumens: 3122.6, LM/W = 88.52, spacing criterion at 0= 1.04, test no. ISF 30712P249.



Ave	Lumens
0	2927
5	2989
15	3120
25	2575
35	1062
45	149
55	3
65	2
75	0
85	0
90	0

Zone	Lumens	% Lamp
0° - 30°	2301.2	73.7
0° - 40°	2968.2	95.1
0° - 60°	3121.1	100.0
0° - 90°	3122.6	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	3122.6	*100.0

*Efficiency

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	96.8	5.8	48.4	8.9	9.7
10.0	52.0	7.9	26.0	12.2	5.2
12.0	32.4	10.0	16.2	15.4	3.2
14.0	22.1	12.1	11.1	18.6	2.2
16.0	16.1	14.2	8.0	21.9	1.6

LUMEN OUTPUT MULTIPLIERS - CCT					
	2700K	3000K	3500K	4000K	5000K
80CRI	0.950	0.966	1.000	1.025	1.101

LUMEN OUTPUT MULTIPLIERS - FINISH			
	Clear (AR)	White (WR)	Black (BR)
Specular (LS)	1.0	N/A	N/A
Semi-specular (LSS)	0.950	N/A	N/A
Matte diffuse (LD)	0.85	N/A	N/A
Painted	N/A	0.87	0.73

Notes
- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 80 typical.

HOW TO ESTIMATE DELIVERED LUMENS IN EMERGENCY MODE

Use the formula below to estimate the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

P = Ouput power of emergency driver. P = 10W

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
The LPW rating is also available at Designlight Consortium.

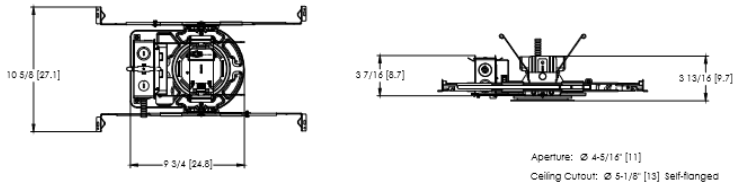
COMPATIBLE 0-10V WALL-MOUNT DIMMERS		
MANUFACTURER	PART NO.	POWER BOOSTER AVAILABLE
Lutron®	Diva® DVTV	
	Diva® DVSCTV	
	Nova T® NTFTV	
	Nova® NFTV	
Leviton®	AWSMT-7DW	CN100
	AWSMG-7DW	PE300
	AMRMG-7DW	
	Leviton Centura Fluorescent Control System	
	IllumaTech® IP7 Series	
Synergy®	ISD BC	RDMFC
	SLD LPCS	
	Digital Equinox (DEQ BC)	
Douglas Lighting Controls	WPC-5721	
Entertainment Technology	Tap Glide TG600FAM120 (120V)	
	Tap Glide Heatsink TGH1500FAM120 (120V)	
	Oasis OA2000FAMU	
Honeywell	EL7315A1019	EL7305A1010 (optional)
	EL7315A1009	
HUNT Dimming	Preset slide: PS-010-IV and PS-010-WH	
	Preset slide: PS-010-3W-IV and PS-010-3W-WH	
	Preset slide, controls FD-010: PS-IFC-010-IV and PS-IFC-010-WH-120/277V	
	Preset slide, controls FD-010: PS-IFC-010-3W-IV and PS-IFC-010-3W-WH-120/277V	
	Remote mounted unit: FD-010	
Lehigh Electronic Products	Solitaire	PBX
PDM Electrical Products	WPC-5721	
Starfield Controls	TR61 with DALI interface port	RT03 DALInet Router
WattStopper®	LS-4 used with LCD-101 and LCD-103	

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

LDN4

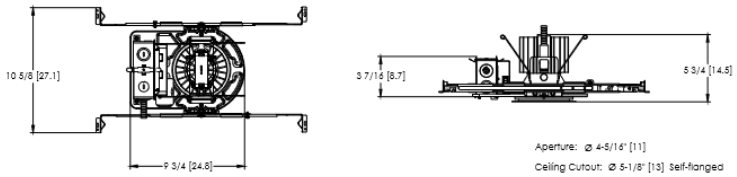
* All dimensions are inches (centimeters) unless otherwise noted.

LDN4 500-2000 Lumens



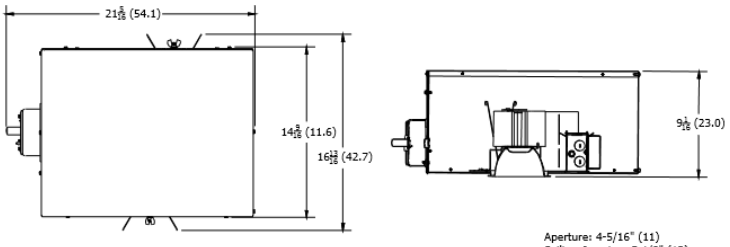
Aperture: Ø 4-5/16" [11]
Ceiling Cutout: Ø 5-1/8" [13] Self-flanged
Overlap Trim: Ø 5-7/16" [13.8]
Ceiling Cutout: Ø 5-1/4" [13.3] Flangeless

LDN4 2000-4000 Lumens



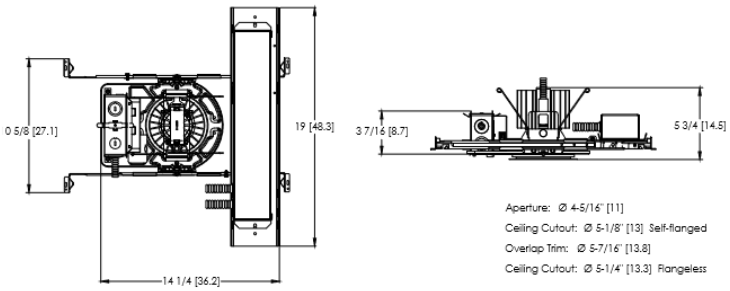
Aperture: Ø 4-5/16" [11]
Ceiling Cutout: Ø 5-1/8" [13] Self-flanged
Overlap Trim: Ø 5-7/16" [13.8]
Ceiling Cutout: Ø 5-1/4" [13.3] Flangeless

LDN4 CP



Aperture: 4-5/16" (11)
Ceiling Opening: 5-1/8" (13)
Overlap Trim: 5-7/16" (13.8)

LDN4 EL



Aperture: Ø 4-5/16" [11]
Ceiling Cutout: Ø 5-1/8" [13] Self-flanged
Overlap Trim: Ø 5-7/16" [13.8]
Ceiling Cutout: Ø 5-1/4" [13.3] Flangeless

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

sensorswitch

Performance You Can Count On

SensorSwitch™ offers standalone wired and wireless lighting controls solutions designed for room-based applications. Our products offer reliable performance and ease of installation.

Sensorswitch.com

Wireless Embedded Controls

1. Install the luminaires with embedded controls
2. Insert the pairing tool into the pinhole on the wall switch; press and hold any button for 6 seconds.
3. Once paired, each fixture will individually dim down to 10% brightness. All products will be fully functional.

SensorSwitch
WSXA SSA

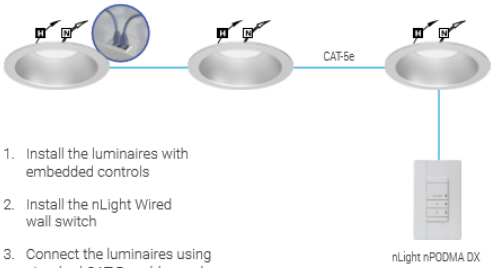
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Embedded Controls



1. Install the luminaires with embedded controls
2. Install the nLight Wired wall switch
3. Connect the luminaires using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Embedded Controls

1. Install the luminaires with embedded controls
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY+ mobile app to pair the fixtures with the wall switch and if desired, customize the sensor settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

EQUIPMENT

MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	LDN4-30/15 L04AR-LS-MVOLT EZ1
TOTAL WATTS	10.58
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	11 3/16" x 9 7/16" x 5 11/16"
FINISH	Specular
RATING	IP
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	1512
ANTICIPATED LIFE	60,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount fixed downlight with one (1) LED lighting source, 1512 delivered lumens, 3000K color engine, 80+ CRI, 55° optic and integral driver. Downlight should operate on MVOLT voltage and be supplied with a 0-10v control option with a 60,000 hour anticipated life. Downlight to have specular finish. Downlight should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

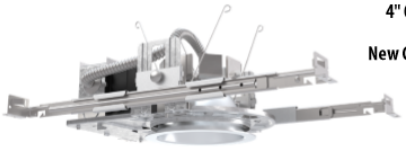
Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

D71

Catalog Number	LDN4-30/15 L04AR-LS-MVOLT EZ1
Notes	
Type	

LDN4 STATIC WHITE

4" Open and Wallwash LED
Non-IC
New Construction Downlight



Open Trim

Wallwash Trim

FEATURES & SPECIFICATIONS

INTENDED USE — Typical applications include corridors, lobbies, conference rooms and private offices.

CONSTRUCTION — Galvanized steel mounting/plaster frame; galvanized steel junction box with bottom-hinged access covers and spring latches. Reflectors are retained by torsion springs.

Vertically adjustable mounting brackets with commercial bar hangers provide 3-3/4" total adjustment.

Two combination 1/2"-3/4" and four 1/2" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out). No. 12 AWG conductors, rated for 90°C.

Accommodates 12"-24" joist spacing.

Passive cooling thermal management for 25°C standard; high ambient (40°C) option available. Light engine and drivers are accessible from above or below ceiling.

Max ceiling thickness 1-1/2".

OPTICS — LEDs are binned to a 3-step MacAdam Ellipse; 80 CRI minimum. 90 CRI optional.

LED light source concealed with diffusing optical lens.

General illumination lighting with 1.0 S/MH and 55° cutoff to source and source image.

Self-flanged anodized reflectors in specular, semi-specular, or matte diffuse finishes. Also available in white and black painted reflectors.

UGR — UGR is zero for fixtures aimed at nadir with a cut-off equeal to or less than 60deg per CIE 117-1996 Discomfort Galre in Interior Lighting. UGR FAQs

ELECTRICAL — Multi-volt (120-277V, 50/60Hz) 0-10V dimming drivers mounted to junction box, 10% or 1% minimum dimming level available.

0-10V dimming fixture requires two (2) additional low-voltage wires to be pulled.

LUMEN MAINTENANCE — 70% lumen maintenance at 60,000 hours.

LISTINGS — Certified to US and Canadian safety standards. Wet location standard (covered ceiling). IP55 rated. Drivers are ROHS compliant

GOVERNMENT PROCUREMENT — BAA – Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA – Build America Buy America: Product with the BAA option also qualifies as produced in the United States under the definitions of the Build America, Buy America Act.

Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

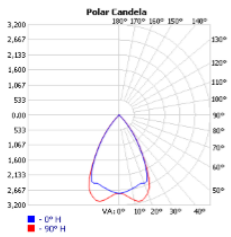
Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

PERFORMANCE DATA

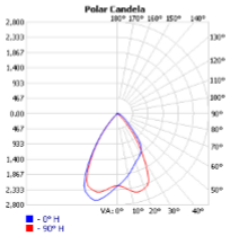
LDN4			
Nominal	**Lumens**	**Wattage**	**Lm/W**
500	523.6	5.74	91.2
750	751.1	8.6	87.3
1000	1045	10.58	98.8
1500	1512	17.5	86.4
2000	2006	22.12	90.7
2500	2551	26.1	97.7
3000	3007	32.1	93.7
4000	4212	43	98.0

Notes
Tested in accordance with IESNA LM-79-08
Tested to current IES and NEMA standards under stabilized laboratory conditions
Based on LDN4 AR LSS 35K 80CRI

DISTRIBUTIONS



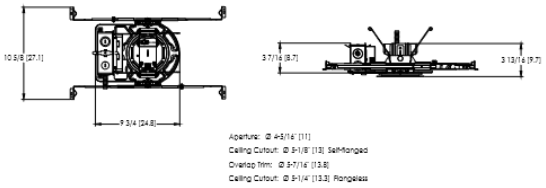
Open



Wallwash

DIMENSIONS

LDN4 500-2000 Lumens



See page 4 for other fixture dimensions

Visual Terrain® www.visualterrain.net		PROJECT: Bentonville Ballroom CLIENT: Live Nation SUBMISSION: 100% Detail Design DOCUMENT #:	**EQUIPMENT TYPE** D72
DATE: 10/23/2026	REVISION #		
PAGE 205 OF 505	0	Equipment Page 2 of 8	

LDN4

D71
LDN4-30/15 L04AR-LS-MVOLT EZ1

Design Select options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LDN4 35/15 L04 AR LSS MVOLT EZ1

LDN4							
Series	**Color temperature**	**Lumens ‡**		**Trim Style**	**Trim Color**	**Trim Finish**	**Flange Color ‡**
LDN4 4" round	27/ 2700K	05 500 lumens	20 2000 lumens	L04 Downlight	AR Clear	LSS Semi-specular	TRW White painted flange
	30/ 3000K	07 750 lumens	25 2500 lumens	LW4 Wallwash	WR ‡ White	LD Matte diffuse	TRBL Black painted flange
	35/ 3500K	10 1000 lumens	30 3000 lumens		BR ‡ Black	LS Specular	FRALTBD RAL painted flange only
	40/ 4000K	15 1500 lumens	40 4000 lumens		TRALTBD ‡ RAL painted trim		FCPC Custom painted flange only
	50/ 5000K				TCPC ‡ Custom painted trim		

Voltage	**Driver**	**Emergency ‡**	**Control Input ‡**
MVOLT Multi-volt	GZ10 0-10V driver dims to 10%	(blank) No emergency option	(blank) No control option
120 120V	GZ1 0-10V driver dims to 1%	EL Emergency battery pack with integral test switch. 10W Constant Power, Not Certified in CA Title 20 MAEDBS	NPP16D nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).
277 277V	D10 Minimum dimming 10% driver for use with SSAIR	ELR Emergency battery pack with remote test switch. 10W Constant Power, Not Certified in CA Title 20 MAEDBS	NPP16DER nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.
347 ‡ 347V	D1 Minimum dimming 1% driver for use with SSAIR	ELSD Emergency battery pack with self-diagnostics, 10W Constant Power, integral test switch. Not Certified in CA Title 20 MAEDBS	N80 nLight™ Lumen Compensation
	EZ1 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1%	ELRSD Emergency battery pack with self-diagnostics, 10W Constant Power, remote test switch. Not Certified in CA Title 20 MAEDBS	SSAIR Wireless standalone embedded control by SensorSwitch
	EDAB eldoLED DALI SOLDRIVE dim to dark	E10WCP Emergency battery pack, 10W Constant Power with integral test switch. Certified in CA Title 20 MAEDBS	NPS80EZ nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1).
		E10WCPR Emergency battery pack, 10W Constant Power with remote test switch. Certified in CA Title 20 MAEDBS	NPS80EZER nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1). ER controls fixtures on emergency circuit.
		E10WRSTAR Emergency battery pack, 10W with remote test switch and Iota STAR technology	NLTAIR2 nLight® Air enabled
			NLTAIRER2 nLight® AIR Dimming Pack Wireless Controls. Controls fixtures on emergency circuit, not available with battery pack options
			NLTAIREM2 nLight® AIR Dimming Pack Wireless Controls. UL924 Emergency Operation, via power interrupt detection. Available with battery pack options.

Options	
HAO ‡	High ambient option (40°C)
CP ‡	Chicago Plenum
RRL___	RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature. Available only in RRLA, RRLB, RRLAE, and RRLC12S.
BAA	Buy America(n) Act and/or Build America Buy America Qualified
90CRI	High CRI (90+)
SF ‡	Single fuse

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

(Maximum order quantity for design select lead times is 160.)

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
Lumen Packages	Overall height varies based on lumen package, refer to dimensional charts on page 4
WR, BR	Not available with finish (LSS, LD, LS)
TRALTBD, FRALTBD	RALTBD for pricing only. Replace with applicable RAL number and finish when ready to order. See the RAL BROCHURE for available color options. Not available with TCPC or FCPC
TRW, TRBL	Available with clear (AR) trim color only
TCPC, FCPC	CPC options for pricing only. Custom color chip needs to be sent in to your Customer Resolution specialist before order can be processed. Click HERE for more details. Not available with TRAL or FRAL
347	Not available with emergency options
All Emergency	12.5" of plenum depth or top access required for battery pack maintenance.
NPP16D, NPP16DER	Not available with MVOLT. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
SF	Must specify 120 or 277 volt
N80	Fixture begins at 80% light level. Must be specified with NPS80EZ or NPS80EZ ER. Only available with EZ10 and EZ1 drivers.
NPP16D, NPP16DER, NPPS80EZ, NPS80EZER	Specify voltage. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
NLTAIR2, NLTAIRER2, NLATAIREM2	Not available with CP, NPS80EZ, NPS80EZER, NPP16D, NPP16DER or N80 options. Not recommended for metal ceiling installations.
NLTAIR2	When combined with EZ1 or EZ10 drivers, can be used as a normal power
SSAIR	Must specify D10 or D1 driver. Not available with nLight options. Not available with CP. Not recommended for metal ceiling installation. Not for use with emergency backup power systems other than battery packs.
HAO	Fixture height is 5-11/16" for all lumen packages with HAO.
CP	Must specify voltage for 3000lm. Not available with emergency battery pack option.
E10WRSTAR	Not available with wet location, EC1, EC6, QDS, CP, 347V, NPS80EZ ER, NLTAIRER2, NLTAIREM2, ALO3 & ALO4 w/DALI, OR 2000-4500 lumens w/SSAIR. Top access installation or 17.5" plenum clearance required for roomside installation. Not available with integral test switch.

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

Accessories: *Order as separate catalog number.*	
EACISSM 375	Compact interruptible emergency AC power system
EACISSM 125	Compact interruptible emergency AC power system
GRA46 JZ	Oversized trim ring with 6" outside diameter
SCA4	Sloped Ceiling Adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA4 10D.

Emergency Battery Pack Options - Field Installable

Battery Model Number	Wattage	Runtime (Minutes)	Lumen Output* @ 120 Lumens/Watt	Other
ILB CP07 2H A	7W	120	840	Storm Shelter/ 2-hour Runtime
ILB CP10 A	10W	90	1200	
ILBLP CP10 HE SD A+	10W	90	1200	Title 20, Self Diagnostic
ILBLP CP15 HE SD A+	15W	90	1800	Title 20, Self Diagnostic
ILB CP20 HE A	20W	90	2400	Title 20
ILB CP20 HE SD A	20W	90	2400	Title 20, Self Diagnostic
ILBHI CP10 HE SD A+	10W	90	1200	347-480V AC Input, Title 20, Self Diagnostic
ILBHI CP15 HE SD A+	15W	90	1800	347-480V AC Input, Title 20, Self Diagnostic

All the above are UL 924 Listed products that are certified for field install external/remote to the fixture.
*Minimum delivered lumen output to assist in product selection for increased fixture mounting height.
The CP10 delivered emergency illuminations outperforms legacy 1400 lumen fluorescent emergency ballasts.
Please contact us at techsupport@iotaengineering.com for any Emergency Battery related questions.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provided consistent color appearance and out-of-the-box control capability with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about A+, visit www.acuitybrands.com/aplus.

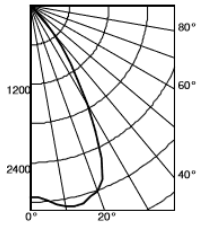
© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

LDN4

PHOTOMETRY

Distribution Curve | **Distribution Data** | **Output Data** | **Illuminance Data at 30" Above Floor for a Single Luminaire**

LDN4 35/30 LO4AR, input watts: 32.1, delivered lumens: 3122.6, LM/W = 88.52, spacing criterion at 0= 1.04, test no. ISF 30712P249.



Ave	Lumens
0	2927
5	2989
15	3120
25	2575
35	1062
45	149
55	3
65	2
75	0
85	0
90	0

Zone	Lumens	% Lamp
0° - 30°	2301.2	73.7
0° - 40°	2968.2	95.1
0° - 60°	3121.1	100.0
0° - 90°	3122.6	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	3122.6	*100.0

*Efficiency

Mounting Height	Inital FC Center Beam	50% beam - 55.6° Diameter	50% beam - 55.6° FC	10% beam - 78.0° Diameter	10% beam - 78.0° FC
8.0	96.8	5.8	48.4	8.9	9.7
10.0	52.0	7.9	26.0	12.2	5.2
12.0	32.4	10.0	16.2	15.4	3.2
14.0	22.1	12.1	11.1	18.6	2.2
16.0	16.1	14.2	8.0	21.9	1.6

LUMEN OUTPUT MULTIPLIERS - CCT					
	2700K	3000K	3500K	4000K	5000K
80CRI	0.950	0.966	1.000	1.025	1.101

LUMEN OUTPUT MULTIPLIERS - FINISH			
	Clear (AR)	White (WR)	Black (BR)
Specular (LS)	1.0	N/A	N/A
Semi-specular (LSS)	0.950	N/A	N/A
Matte diffuse (LD)	0.85	N/A	N/A
Painted	N/A	0.87	0.73

Notes
- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 80 typical.

HOW TO ESTIMATE DELIVERED LUMENS IN EMERGENCY MODE

Use the formula below to estimate the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

P = Ouput power of emergency driver. P = 10W

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
The LPW rating is also available at Designlight Consortium.

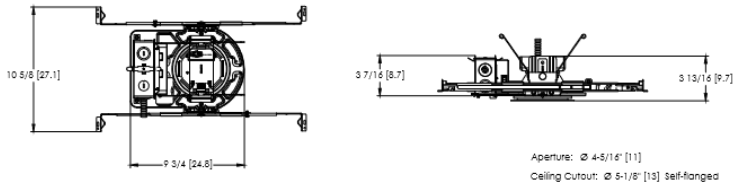
COMPATIBLE 0-10V WALL-MOUNT DIMMERS		
MANUFACTURER	PART NO.	POWER BOOSTER AVAILABLE
Lutron®	Diva® DVTV	
	Diva® DVSCTV	
	Nova T® NTFTV	
	Nova® NFTV	
Leviton®	AWSMT-7DW	CN100
	AWSMG-7DW	PE300
	AMRMG-7DW	
	Leviton Centura Fluorescent Control System	
	IllumaTech® IP7 Series	
Synergy®	ISD BC	RDMFC
	SLD LPCS	
	Digital Equinox (DEQ BC)	
Douglas Lighting Controls	WPC-5721	
Entertainment Technology	Tap Glide TG600FAM120 (120V)	
	Tap Glide Heatsink TGH1500FAM120 (120V)	
	Oasis OA2000FAMU	
Honeywell	EL7315A1019	EL7305A1010 (optional)
	EL7315A1009	
HUNT Dimming	Preset slide: PS-010-IV and PS-010-WH	
	Preset slide: PS-010-3W-IV and PS-010-3W-WH	
	Preset slide, controls FD-010: PS-IFC-010-IV and PS-IFC-010-WH-120/277V	
	Preset slide, controls FD-010: PS-IFC-010-3W-IV and PS-IFC-010-3W-WH-120/277V	
	Remote mounted unit: FD-010	
Lehigh Electronic Products	Solitaire	PBX
PDM Electrical Products	WPC-5721	
Starfield Controls	TR61 with DALI interface port	RT03 DALInet Router
WattStopper®	LS-4 used with LCD-101 and LCD-103	

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

LDN4

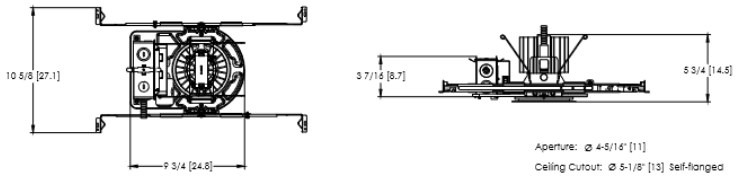
* All dimensions are inches (centimeters) unless otherwise noted.

LDN4 500-2000 Lumens



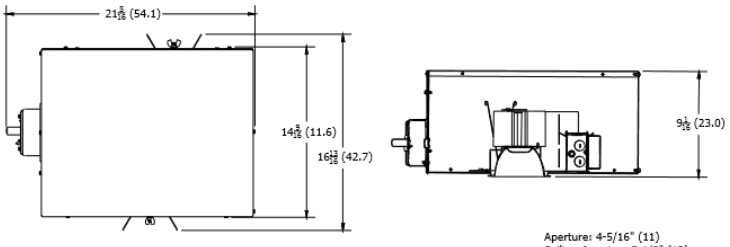
Aperture: Ø 4-5/16" [11]
Ceiling Cutout: Ø 5-1/8" [13] Self-flanged
Overlap Trim: Ø 5-7/16" [13.8]
Ceiling Cutout: Ø 5-1/4" [13.3] Flangeless

LDN4 2000-4000 Lumens



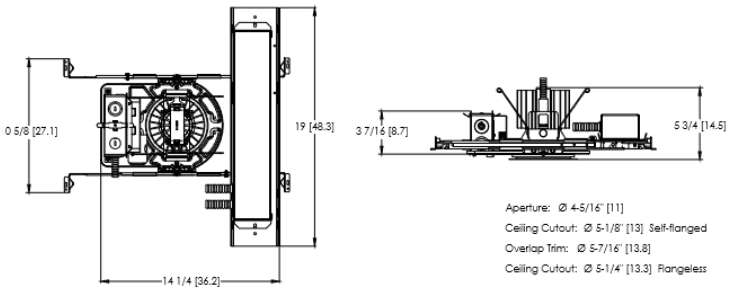
Aperture: Ø 4-5/16" [11]
Ceiling Cutout: Ø 5-1/8" [13] Self-flanged
Overlap Trim: Ø 5-7/16" [13.8]
Ceiling Cutout: Ø 5-1/4" [13.3] Flangeless

LDN4 CP



Aperture: 4-5/16" (11)
Ceiling Opening: 5-1/8" (13)
Overlap Trim: 5-7/16" (13.8)

LDN4 EL



Aperture: Ø 4-5/16" [11]
Ceiling Cutout: Ø 5-1/8" [13] Self-flanged
Overlap Trim: Ø 5-7/16" [13.8]
Ceiling Cutout: Ø 5-1/4" [13.3] Flangeless

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

sensorswitch

Performance You Can Count On

SensorSwitch™ offers standalone wired and wireless lighting controls solutions designed for room-based applications. Our products offer reliable performance and ease of installation.

Sensorswitch.com

Wireless Embedded Controls

1. Install the luminaires with embedded controls
2. Insert the pairing tool into the pinhole on the wall switch; press and hold any button for 6 seconds.
3. Once paired, each fixture will individually dim down to 10% brightness. All products will be fully functional.

SensorSwitch
WSXA SSA

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

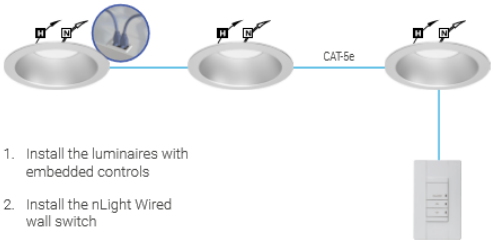
nLIGHT

Single Lighting Controls Platform for Indoor & Outdoor Spaces

nLight® is your networked lighting controls platform, for indoor and outdoor applications, providing wired or wireless options. Scaling from room to campus-wide applications, it is the one platform that grows with your business today and tomorrow; to seamlessly address energy cost optimization, building code compliance, improved occupant comfort, and much more. nLight also interfaces with DALI®, BACnet®, DMX and additional third-party devices.

nLightcontrols.com

Wired Embedded Controls



1. Install the luminaires with embedded controls
2. Install the nLight Wired wall switch
3. Connect the luminaires using standard CAT-5e cables and the controls devices will automatically discover each other and work (plug and play)

Wireless Embedded Controls

1. Install the luminaires with embedded controls
2. Install the nLight AIR battery-powered wall switch
3. Use CLAIRITY+ mobile app to pair the fixtures with the wall switch and if desired, customize the sensor settings

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

© 2015-2025 Acuity Brands Lighting, Inc. All rights reserved. Rev. 10/07/25

EQUIPMENT

MANUFACTURER	TRACE LITE
CATALOG NUMBER	LPA22-30-3K
TOTAL WATTS	30
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	5.7 lbs
DIMENSIONS	2′ x 2′ x 2.2″
FINISH	White
RATING	IP20
LISTING	ETL

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	3736
ANTICIPATED LIFE	100,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

Recessed mount layin troffer with one (1) LED lighting source, 3736 delivered lumens, 3000K color engine, 80+ CRI, direct optic and integral driver. Troffer should operate on 120 -277 voltage and be supplied with a 0-10v control option with a 100,000 hour anticipated life. Troffer to have white finish. Troffer to be rated for IP20 or equivalent. Troffer should be UL listed for damp use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

TRACE•LITE
commercial & industrial lighting

D91
LPA22-30-3K

LPA Series
Premium LED Flat Panel

Model: _____ Date: _____
Accessories: _____
Job Name: _____ Type: _____

INVENTORY CLOSEOUT

DESCRIPTION
Trace-Lite's LPA Advantage Series of backlit LED panels offers incredible performance in an energy-efficient, slim profile package available in 1' x 4', 2' x 2' and 2' x 4' configurations. Ideal for office spaces, schools, hospitals and any indoor location that requires even illumination and lower maintenance. The LPA Series is compatible with most standard T-bar grid ceilings and includes 0-10V dimming standard. Trace-Lite LED panels offer soft and uniform light with PMMA optical lensing that will not yellow over time. All panels are packaged in a quantity of four.

SPECIFICATIONS
Construction:
- Precision die-formed steel enclosure in a white finish
- Aluminum frame with seamless corners
- Recessed design fits most standard T-bar grid ceilings
- Backlit design, LEDs sit at the back of the enclosure aimed directly at the diffuser to evenly illuminate the entire surface of the panel
- Sturdy frame prevents warping due to the slightly more elevated profile

Optics/LEDs:
- UV-stabilized PMMA optical lenses over the LEDs that will not yellow over time
- Soft and uniform light distribution, 120° beam
- Efficacies up to 140 LPW to maximize energy savings and utility rebates
- CRI ≥ 80
- L70 > 100,000 hours

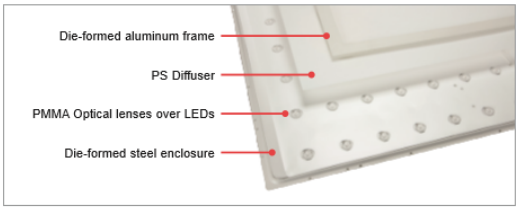
Electrical:
- 120-277VAC, 50/60Hz
- 0-10V Dimming driver
- Power supply with high power factor of 90% typical

Testing & Compliance:
- cETL Listed, rated for insulated ceilings (IC Rated)
- Meets IP20 rating, Damp Location
- Operating temperatures: -10°C to 40°C (14°F to 40°C)

Installation:
- Unit simply lifts through grid ceiling and rests on T-bars
- Easy installation in new construction or retrofit
- Standard recessed mounting in most 1' x 4', 2' x 2' or 2' x 4' grid ceilings
- Earthquake clips included

Warranty:
- Five Year Warranty (Terms and Conditions Apply)

Intertek DAMP 5 YEAR WARRANTY



Backlit design for even illumination

Specs at a Glance							
Configuration	LPA14 (1' x 4')		LPA22 (2' x 2')			LPA24 (2' x 4')	
Wattage (W)*	30W		30W			40W	
CCT (K)	3000K	4000K	3000K	3500K	5000K	3500K	5000K
Lumens (lm)	3698	3742	3736	3776	3933	5196	5468
Efficacy (LPW)	126	127	127	128	133	134	140
CRI	>80						
Input Voltage	120-277VAC, 50/60Hz, 0-10V Dimmable						
Operating Temp	-10°C to 40°C (14°F to 104°F)						
Certifications	cETL Listed, IC Rated						
Warranty	5 Years						
Weight	5.7 lbs		5.7 lbs			10.9 lbs	

Specifications are subject to change without notice.
Installation must be performed in accordance with Barron Lighting Group installation instructions.

10800376 Rev 21

BARRON lighting group
800.533.3948 • barronltg.com

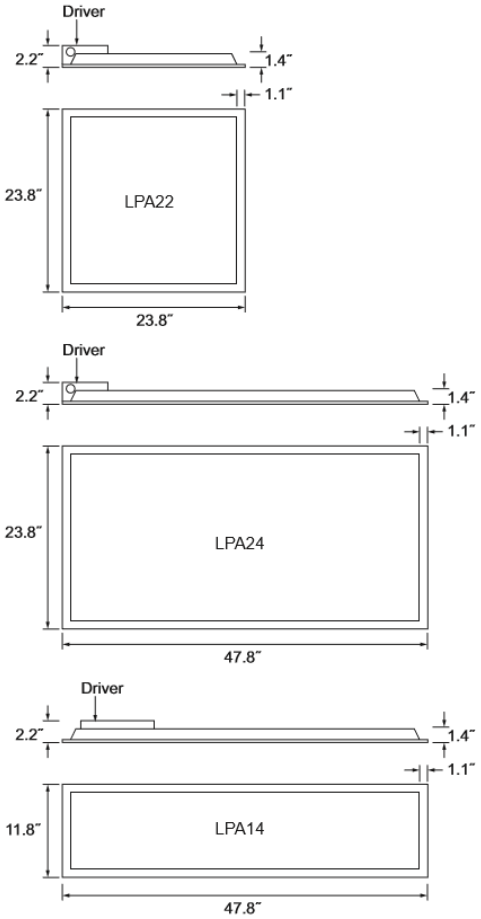
Ordering Information (Example: LPA22-30-5KV)

Part Number[1]	Description
LPA14-30-3KV	1'x4' Backlit LED Flat Panel, 30W, 3000K CCT, 120-277 Volt, 1-10V Dimming Driver, White Finish
LPA14-30-4KV	1'x4' Backlit LED Flat Panel, 30W, 4000K CCT, 120-277 Volt, 1-10V Dimming Driver, White Finish
LPA22-30-3KV	2'x2' Backlit LED Flat Panel, 30W, 3000K CCT, 120-277 Volt, 1-10V Dimming Driver, White Finish
LPA22-30-35KV	2'x2' Backlit LED Flat Panel, 30W, 3500K CCT, 120-277 Volt, 1-10V Dimming Driver, White Finish
LPA24-40-35KV	2'x4' Backlit LED Flat Panel, 40W, 3500K CCT, 120-277 Volt, 1-10V Dimming Driver, White Finish
LPA24-40-5KV	2'x4' Backlit LED Flat Panel, 40W, 5000K CCT, 120-277 Volt, 1-10V Dimming Driver, White Finish

Notes

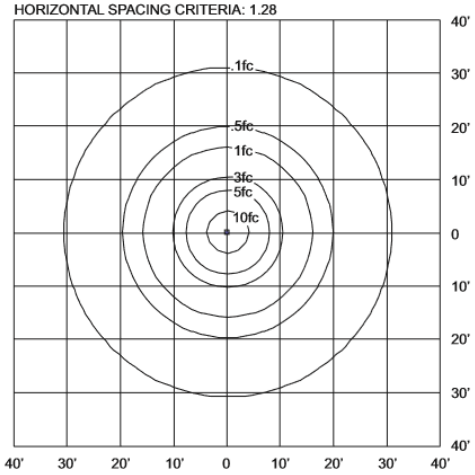
[1] All panels are packaged in quantity of four (4pcs/carton)

Dimensions

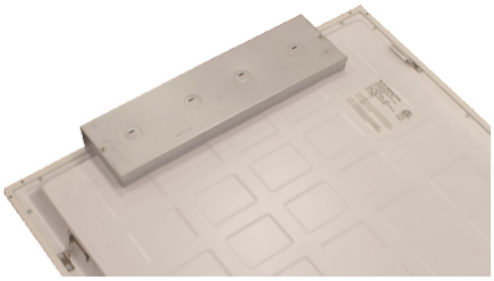


Sample Photometry

LPA22-30-4KV
IES: TYPE VS Very Short
MOUNTING HEIGHT: **10'**
TILT: ZERO
HORIZONTAL SPACING CRITERIA: 1.28



Driver Detail



Specifications are subject to change without notice.
Installation must be performed in accordance with
Barron Lighting Group installation instructions.

10800376 Rev 21

BARRON lighting group
800.533.3948 • barronltg.com

Visual Terrain® www.visualterrain.net		PROJECT: Bentonville Ballroom CLIENT: Live Nation	**EQUIPMENT TYPE**
DATE: 10/23/2026	REVISION #	SUBMISSION: 100% Detail Design DOCUMENT #:	D91
PAGE 214 OF 505	0	Equipment Page 3 of 3	

EQUIPMENT

MANUFACTURER	N/A
CATALOG NUMBER	N/A
TOTAL WATTS	100
VOLTAGE	120
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	
FINISH	
RATING	IP
LISTING	

SOURCE

POWER SUPPLY

TYPE	
PROVIDED BY	

ACCESSORIES

NOT AVAILABLE

Recessed mount fixed junction box. Junction Box should operate on 120 voltage and be supplied with a relay control option.

CONTROL

PROTOCOL	RELAY
INTENT	

NOTES

Contractor supplied box to be integrated into control system. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

EQUIPMENT

MANUFACTURER	Williams
CATALOG NUMBER	S10-H-L3/830-FTG-BLK-DIM-277
TOTAL WATTS	13.8
VOLTAGE	277
MOUNTING	Wall
WEIGHT	
DIMENSIONS	10" x 3.5" x 5"
FINISH	Black
RATING	IP
LISTING	UL Wet Listed

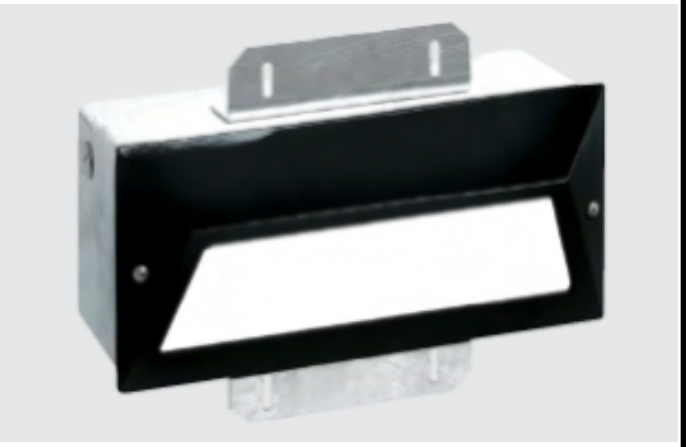
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000k
CRI	80+
LUMEN OUTPUT	300
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	N/A

ACCESSORIES



Wall mount fixed steplight with one (1) LED lighting source, 300 delivered lumens, 3000k color engine, 80+ CRI, 13.8w optic and integral driver. Steplight should operate on 277 voltage and be supplied with a 0-10v control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Steplight to have black finish. Steplight should be UL listed for wet use or an approved equivalent.

CONTROL

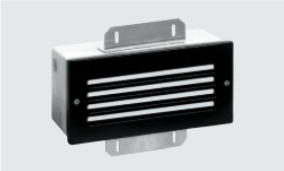
PROTOCOL	0-10V
INTENT	

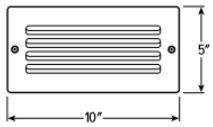
NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

S10 LED
10″ Rectangular Step Light

Williams





Grill Front View

CATALOG #:

Type:

PROJECT:

FEATURES

- Sealed for weather tight performance
- Choice of open, hooded and grill faceplates in a variety of finishes
- LEDs provide high-efficacy and a variety of color temperature options
- LED module with driver allows for easy replacement or upgrades
- Available with frosted or opal lens
- Adjustable mounting brackets
- Designed for concrete pour applications
- Made Right Here® in the USA

SPECIFICATIONS

- HOUSING – Minimum .188″ thick cast aluminum housing with two 1/2″ NPS threaded hub and plugged conduit entry points.
- SHIELD – Removable cast aluminum shield gasketed and secured with countersunk, stainless steel allen head screws.
- LENS – Polycarbonate or frosted tempered glass, sealed with silicone.
- FINISH – Super durable polyester powder coat meets and exceeds AAMA 2604 specifications for outdoor durability.
- ELECTRICAL – High quality mid-power LED board. Rated for 50,000 hours at 70% lumen maintenance (L70). Prewired at factory for easy field installation.
- MOUNTING – Recessed wall mount. Adjustable aluminum mounting brackets provided.
- LISTINGS –
  - cETLus conforms to UL STD 1598; Certified to CAN/CSA STD C22.2 No. 250.0. Suitable for wet locations.
  - RoHS compliant.
  - Complies with the Buy American Act and other federal regulations. Request certification at hew.com/baa.
- WARRANTY – 5-year limited warranty, see hew.com/warranty.

ORDERING EXAMPLE: S10 - G - L3/840 - FTG - DBZ - DIM - 120

ORDERING INFO

SERIES	FACEPLATE STYLE	LUMENS [1]	CRI	CCT	LENS
S10	O Open	L3 300lm	8 80	27 2700K	FTG Frosted tempered glass, .188″ thick
	H Hood			30 3000K	OPAL Opal polycarbonate, .125″ thick
	G Grill			35 3500K	
				40 4000K	

FACEPLATE FINISH [2]		DRIVER	VOLTAGE
BLK	Black [3]	DIM Dimming driver prewired for 0-10V low voltage applications	120 120V
DBZ	Dark bronze		277 277V
DBR	Medium bronze		
GRAY	Standard gray		
GRN	Green [4]		
SLV	Satin aluminum [5]		
WHT	White [6]		
RAL#____	Specify custom color		

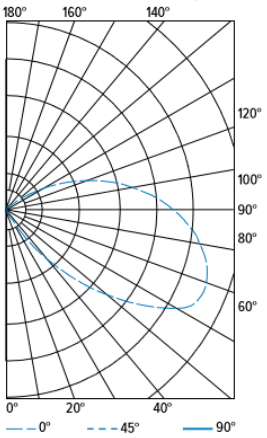
NOTES

1 Lumen output based on 4000K CCT, G faceplate style and FTG lens. Actual lumens may vary +/-5%.
2 See page 4 for FACEPLATE FINISH OPTIONS.
3 RAL #9004.
4 RAL #6005.
5 RAL #9006.
6 RAL #9003.

S10 LED
10" Rectangular Step Light

PHOTOMETRY

S10-G-L3/840-FTG-DBZ-120 Report #: ITL86573; 01/28/16 | Total Luminaire Output: 271 lumens; 13.8 Watts | Efficacy: 19.6 lm/W | 83 CRI; 4076K CCT



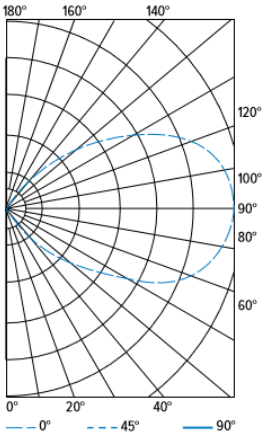
CANDLEPOWER DISTRIBUTION

VERTICAL ANGLE	HORIZONTAL ANGLE 0°	ZONAL LUMENS
0	0	
5	1	0
15	3	0
25	7	1
35	37	5
45	88	15
55	144	31
65	181	47
75	176	52
85	155	48
90	141	
95	125	36
105	89	23
115	51	10
125	14	2
135	1	0
145	1	0
155	0	0
165	0	0
175	0	0
180	0	

LUMEN SUMMARY

ZONE	LUMENS	% FIXTURE
0 - 30	1	1
0 - 40	6	2
0 - 60	52	19
0 - 90	199	74
90 - 180	72	27
0 - 180	271	100

S10-O-L3/830-FTG-BLK 09/07/16 | Total Luminaire Output: 610 lumens; 10.7 Watts | Efficacy: 57.0 lm/W | 80 CRI; 4000K CCT



CANDLEPOWER DISTRIBUTION

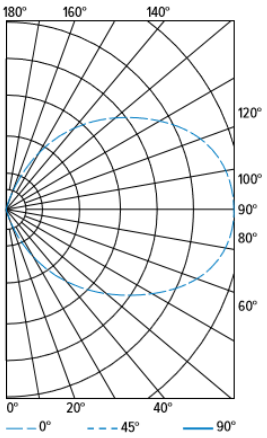
VERTICAL ANGLE	HORIZONTAL ANGLE 0°	ZONAL LUMENS
0	0	
5	0	0
15	1	0
25	8	1
35	28	4
45	88	14
55	166	35
65	255	62
75	308	86
85	332	100
90	336	
95	331	100
105	316	87
115	255	63
125	173	37
135	97	16
145	33	5
155	12	1
165	2	0
175	0	0
180	0	

LUMEN SUMMARY

ZONE	LUMENS	% FIXTURE
0 - 30	1	0
0 - 40	5	1
0 - 60	55	9
0 - 90	302	49
90 - 180	309	51
0 - 180	610	100

S10 LED
10" Rectangular Step Light

S10-O-L3/830-OPAL-BLK 09/07/16 | Total Luminaire Output: 433 lumens; 10.7 Watts | Efficacy: 40.5 lm/W | 80 CRI; 4000K CCT



CANDLEPOWER DISTRIBUTION

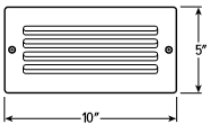
VERTICAL ANGLE	HORIZONTAL ANGLE 0°	ZONAL LUMENS
0	0	
5	0	0
15	7	1
25	30	4
35	64	10
45	93	20
55	121	31
65	149	42
75	174	52
85	182	57
90	181	
95	181	57
105	170	52
115	153	43
125	128	31
135	95	20
145	63	10
155	31	4
165	8	1
175	0	0
180	0	

LUMEN SUMMARY

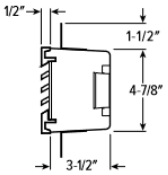
ZONE	LUMENS	% FIXTURE
0 - 30	4	0
0 - 40	14	3
0 - 60	64	15
0 - 90	216	50
90 - 180	218	50
0 - 180	433	100

CROSS SECTIONS

GRILL

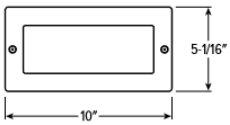


Front View

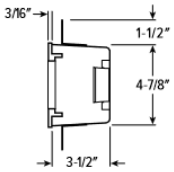


Side View

OPEN

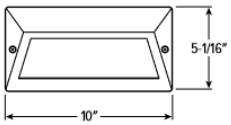


Front View

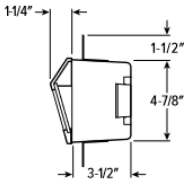


Side View

HOODED



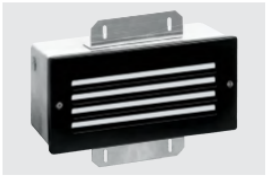
Front View



Side View

FACEPLATE STYLES

GRILL

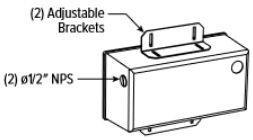


OPEN

HOODED

S10 LED
10″ Rectangular Step Light

MOUNTING DETAILS



Recessed wall mount. Aluminum brackets allow adjustable recessed wall mounting. Two 1/2″ NPS threaded hub and plugged conduit entry points.

FACEPLATE FINISH OPTIONS

WHITE | BLACK | GREEN | MEDIUM BRONZE | DARK BRONZE | SATIN ALUMINUM | GRAY

For custom color, please specify RAL code or a manufacturer code with description. All custom colors other than RAL require two sample swatches, minimum 1″ square.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-12FT03-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	84
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	14-0’ x 3” x 3 3/8”
FINISH	White Powder Coat
RATING	IP
LISTING	UL

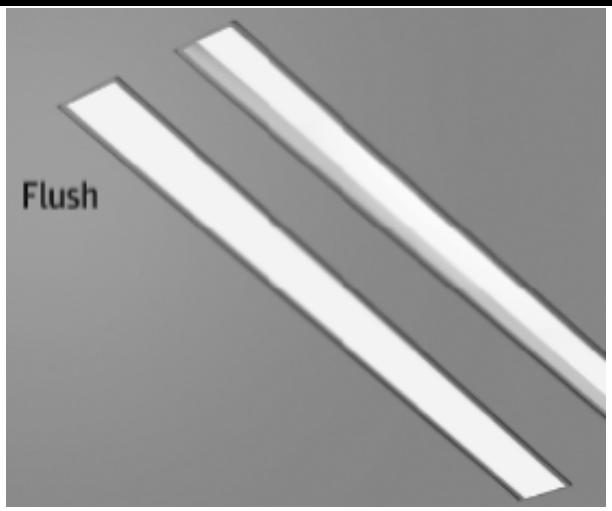
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	6529
ANTICIPATED LIFE	65,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 6529 delivered lumens, 3000K color engine, 90+ CRI and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 65,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

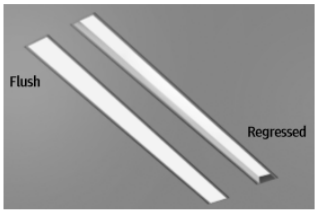
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

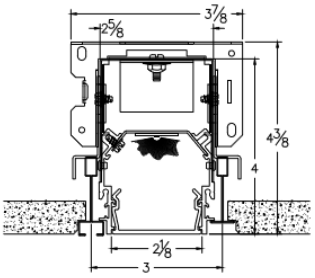
To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Technical Drawing



Flush - (FLP)

Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

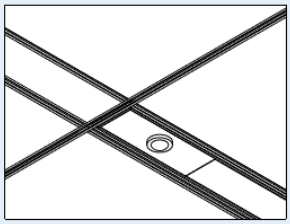
Note: *UGR data available on Page 5*

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series
- SL2L — Slot 2 LED Linear Recessed

Linear Length Plan
- LOP — Linear Optimized Plan

Total Run Length
- 2FT 2'
- 3FT 3'
- 4FT 4'
- 5FT 5'
- 6FT 6'
- 7FT 7'
- 8FT 8'
- _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
- _FT **Specify continuous linear feet in 1 foot increments

Fixture Style
- RLP[1,3] Regressed Lens
- FLP[2] Flush Lens

Ceiling Trim
- FL[4] 5/8" Flange(sheetrock)
- FLINB[21,22] 5/8" Flange (sheetrock) Install From Below
- TG 9/16" or 15/16" Flat or Inverted Tee
- GB[4] Trimless (sheetrock)
- WFL Perimeter Mount, 5/8" Flange (Sheetrock)
- WTG 9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering
- 80CRI 80 CRI
- 90CRI 90 CRI

MVOLT

Direct LED Color Temp
- 27K* 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K* 5000K

Direct LED Light Output
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution
- (blank) Standard Distribution
- WW[5] Wall Wash

Minimum Dimming Level
- NODIM Non - Dim
- MIN1 Constant current, dimming to 1%
- DARK Constant current, dimming to 0.1%
- MIN10[15] Constant current, dimming to 10%

Voltage
- 120 120V
- 277 277V
- 347[7] 347V

Finish
- (blank) White (satin)
- xxx/BLKT Black (satin)
- xxx/SLVT Silver (satin)
- xxx/AMF Anti-Microbial White (satin)
- xxx/RALTBD RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options
- (blank) No Emergency
- _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack
- _EC[10] # of Emergency Circuits
- WEC[6] Entire run on EC

Control Input
- (blank) Non-dim[11]
- ZT 0 10V
- NLIGHT nLight enabled
- NLTAIR2[17] nLight Air (Wireless Enabled)
- ECOD[8,16] Lutron Hi-Lume digital driver
- DALI[19] Dali

* Requires longer lead time.

Primary Sensor[12]
- (blank) Single Zone, No Sensor
- NS Multi-zone, No Sensor Main Zone, No Sensors
- PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
- ADC[13] Daylight Dimming Sensor
- API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
- APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]
- (blank) No additional zones/sensors
- SNS Multi-zone, with no sensor in secondary zone, No Sensors
- SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
- SADC[13] Daylight Dimming Sensor, No Sensors
- SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
- SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone
- (blank) No additional zones/sensors
- TNS Multi-zone, with no sensor in tertiary zone

Options
- CP[18] Chicago Plenum
- BAA Buy America(n) Act and/or Build America Buy America Qualified
- WL[3,9,20] Wet Location Listing
- DPL[20] Damp Location Listing
- PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes
1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

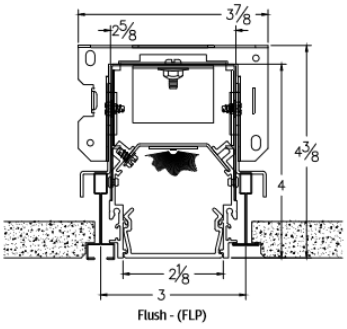
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

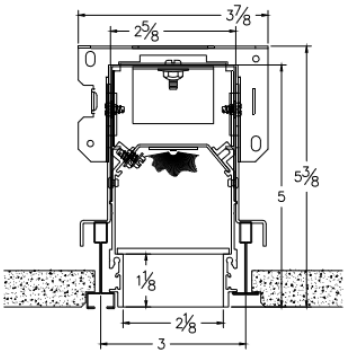
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

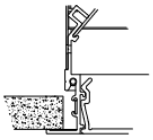


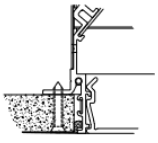
Flush - (FLP)

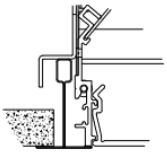


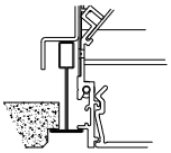
Regressed - (RLP)

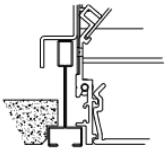
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

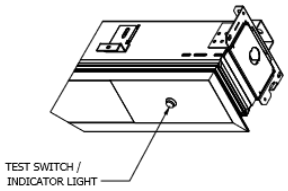

TG
(15/16" Grid)


TG
(9/16" Grid)

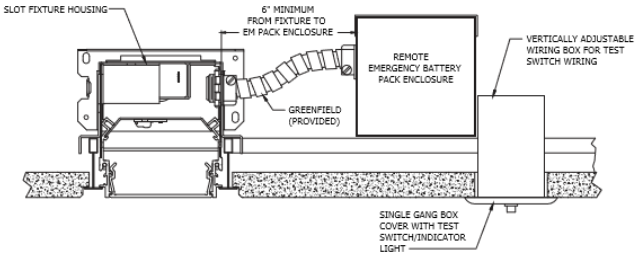

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

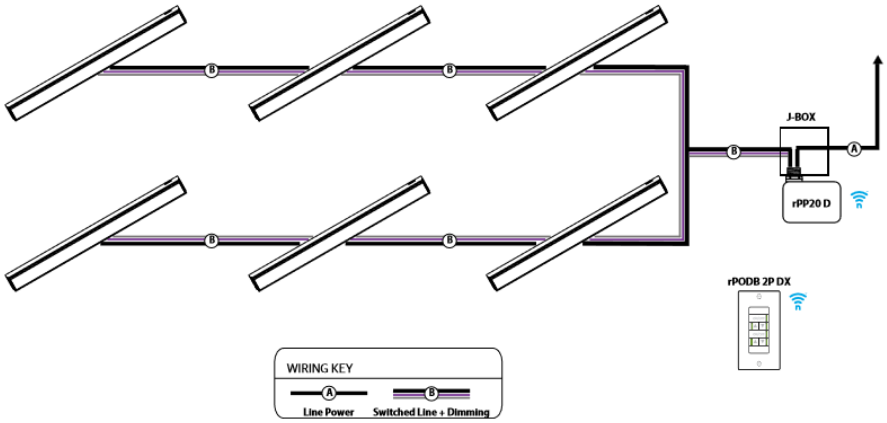
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

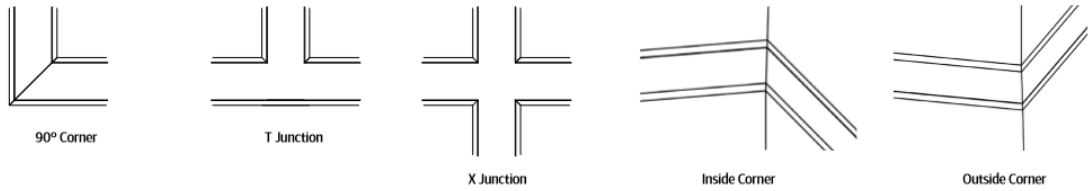


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

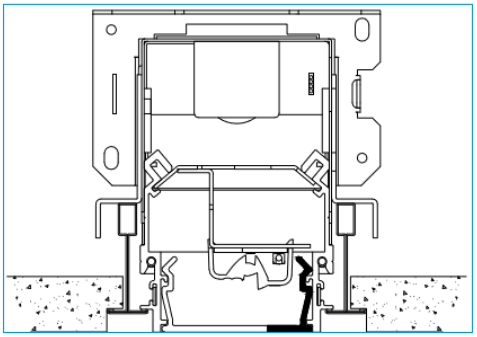
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

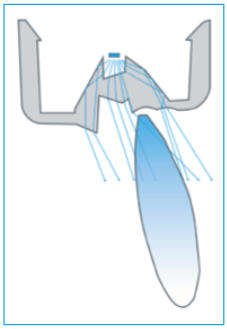
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

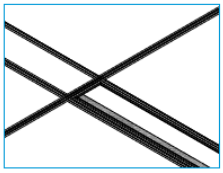
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

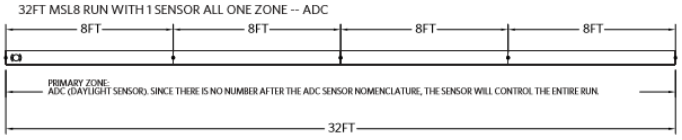




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

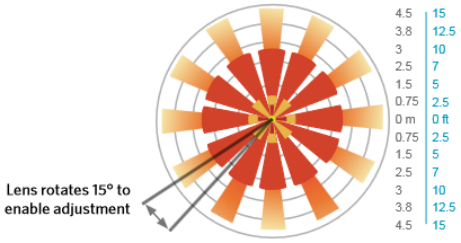
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	106
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	17'-8" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

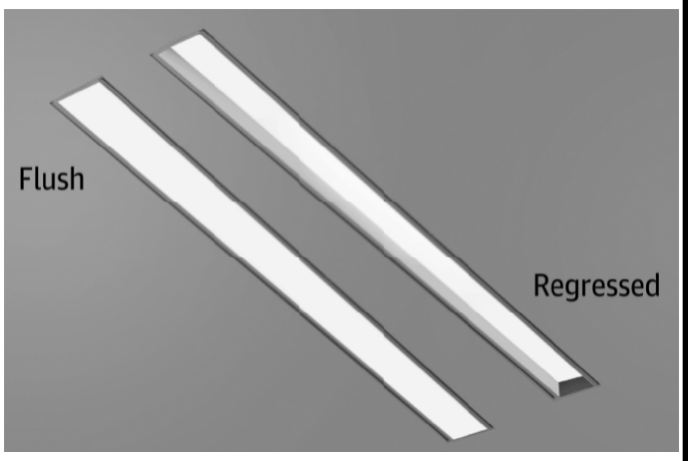
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	600LM/FT
ANTICIPATED LIFE	65000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600LM/FT delivered lumens, 3000K color engine, 90+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 65000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

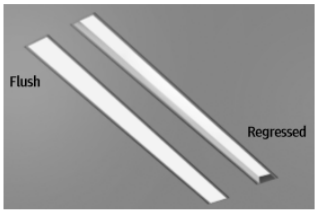
PROTOCOL	0-10V
INTENT	

NOTES

Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

MARK
ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Type:

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

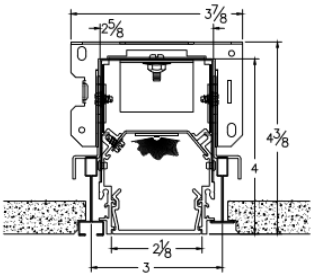
Certification
CSA tested to UL 1598 standards. Optional Damp or Wet location listings available, see ordering tree. This product is IC rated.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.
All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.
To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Technical Drawing



Flush - (FLP)

Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

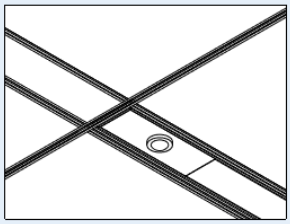
Note: *UGR data available on Page 5*

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2023 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits

Control Input

(blank)	Non-dim[11]
ZT	0 10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD*[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
SADC[13]	Daylight Dimming Sensor
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Compliant
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. No longer applicable.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, downlights or 2' or 3' units. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs, the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

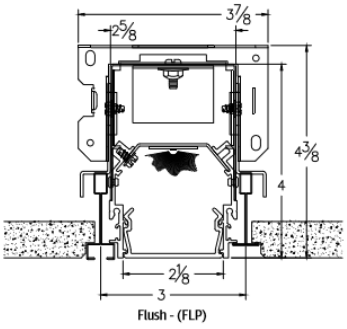
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2023 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

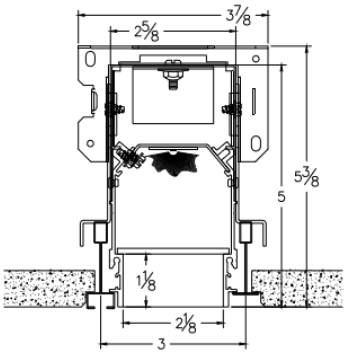
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

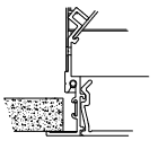


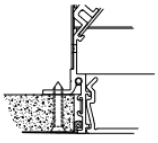
Flush - (FLP)

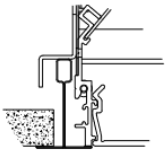


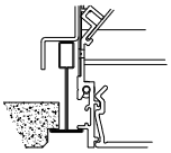
Regressed - (RLP)

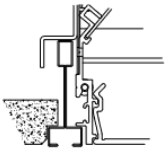
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

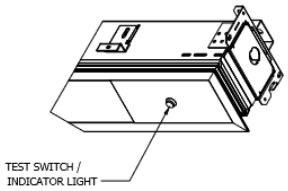

TG
(15/16" Grid)


TG
(9/16" Grid)

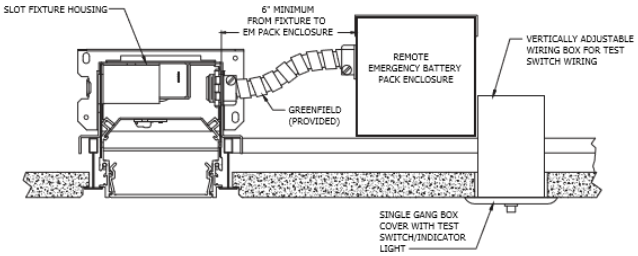

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

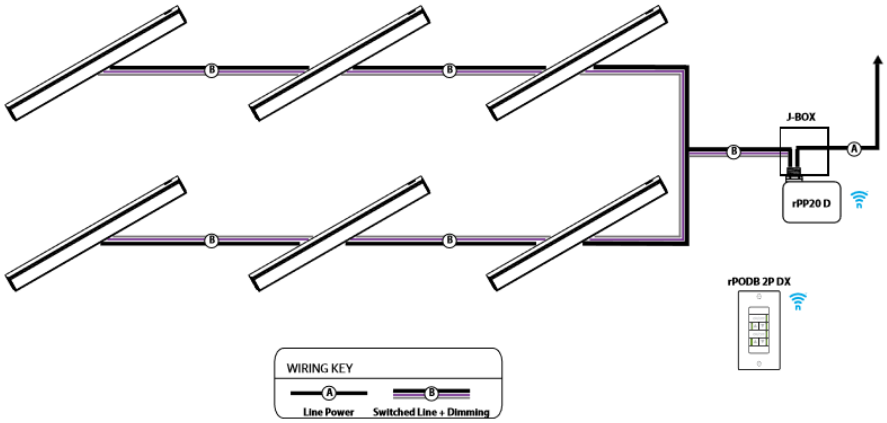
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2023 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

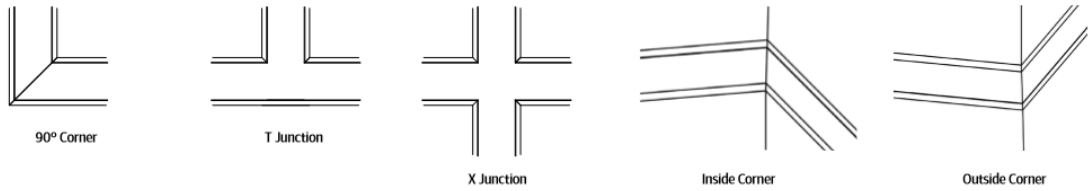


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



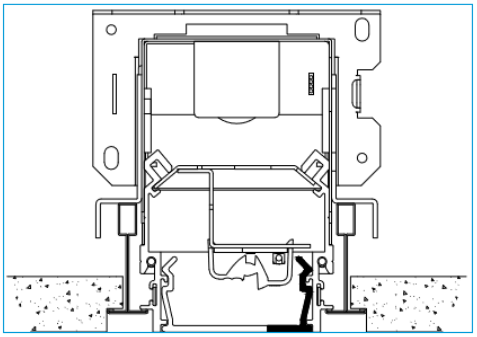
Layout Sketch

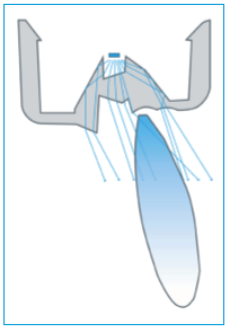
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2023 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

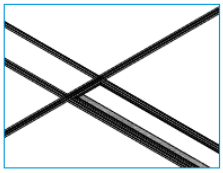
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

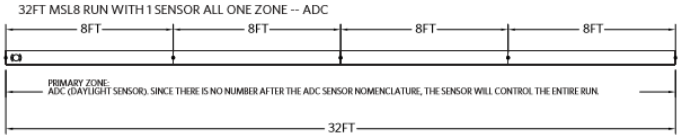




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

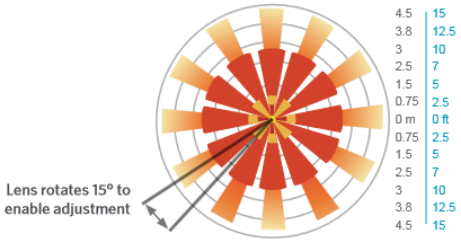
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2023 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-20FT07-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	105
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	17'-6" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

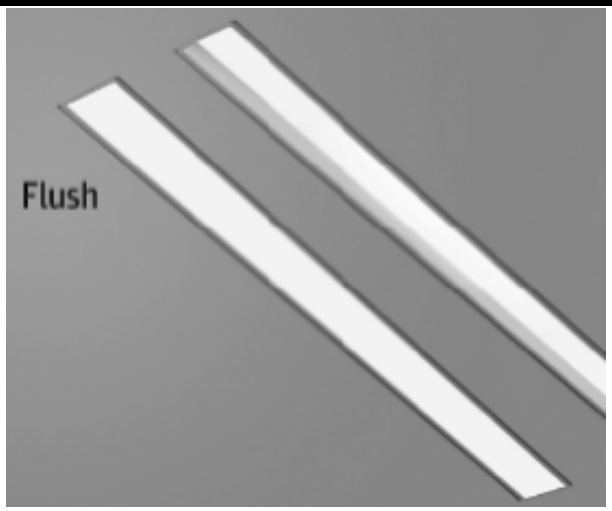
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	600LM/FT
ANTICIPATED LIFE	65,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600LM/FT delivered lumens, 3000K color engine, 90+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 65,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

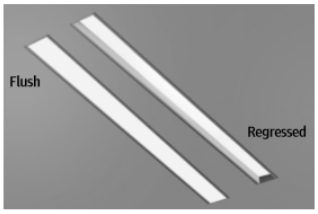
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

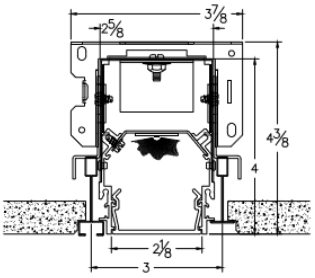
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



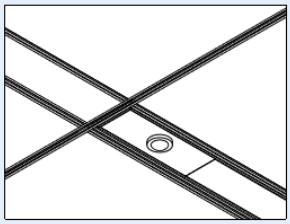
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

MVOLT

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/AMF	Anti-Microbial White (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits
WEC[6]	Entire run on EC

Control Input

(blank)	Non-dim[11]
ZT	0-10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

* Requires longer lead time.

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone, No Sensors
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone, No Sensors
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
SADC[13]	Daylight Dimming Sensor, No Sensors
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Act and/or Build America Buy America Qualified
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

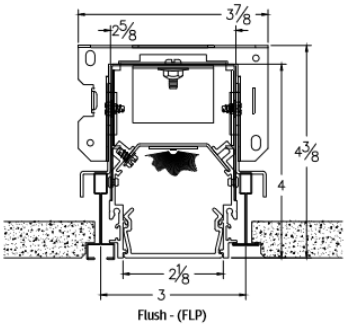
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

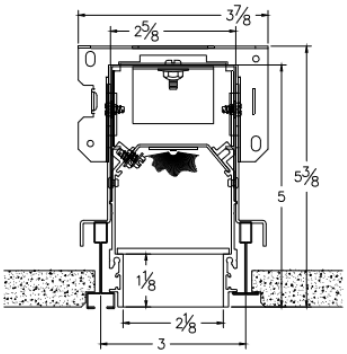
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

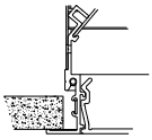


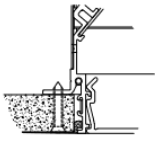
Flush - (FLP)

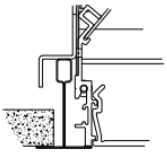


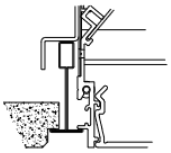
Regressed - (RLP)

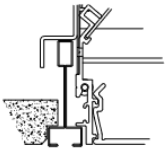
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

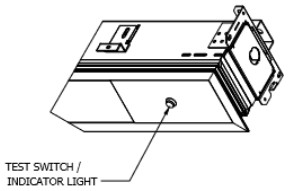

TG
(15/16" Grid)


TG
(9/16" Grid)

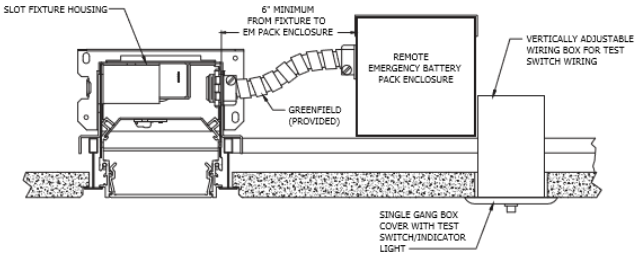

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

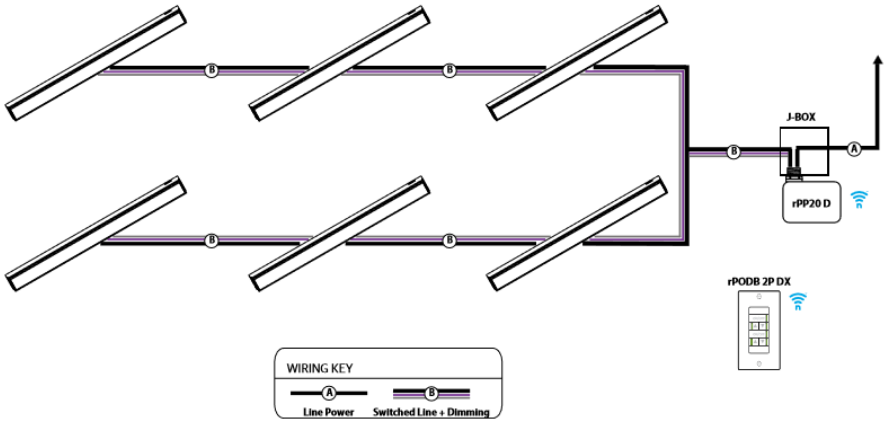
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

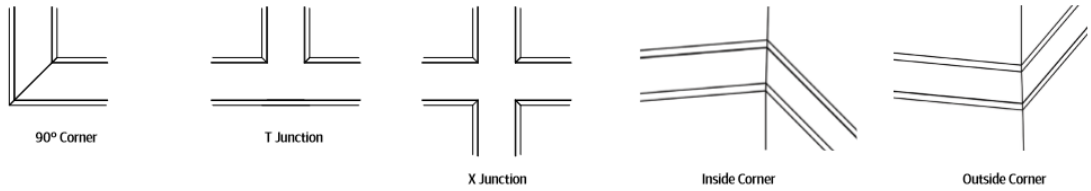


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

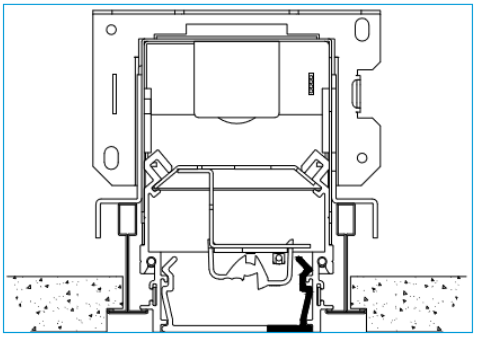
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

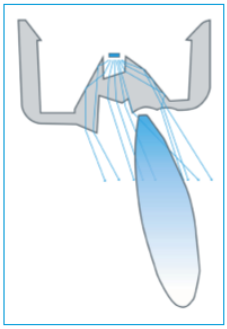
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

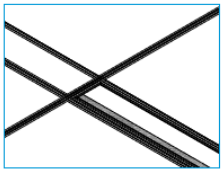
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

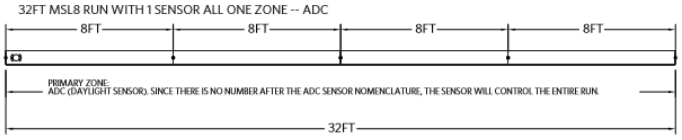




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

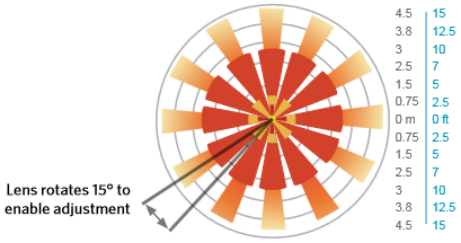
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-23FT00-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	198.5
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	33'-1 x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

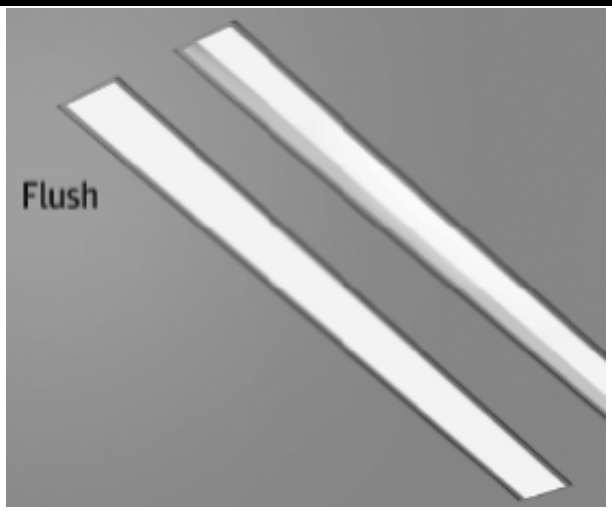
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	600LM/FT
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600LM/FT delivered lumens, 3000K color engine, 90+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

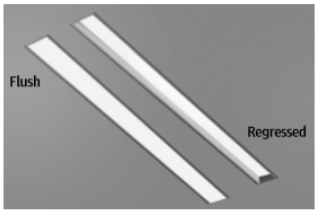
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

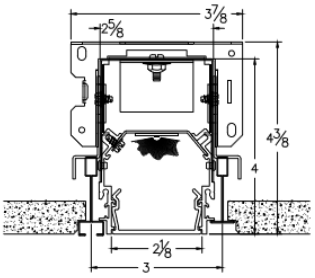
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



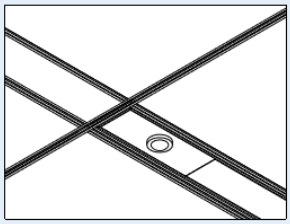
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

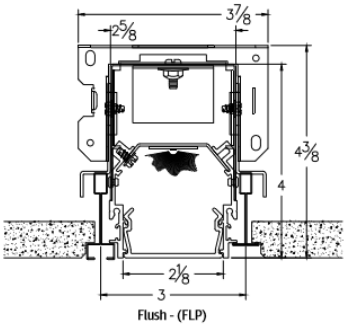
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

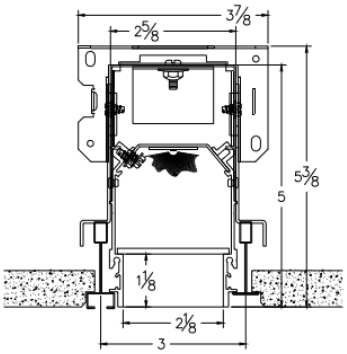
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

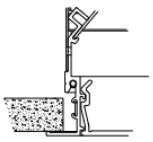


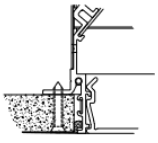
Flush - (FLP)

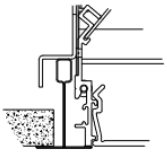


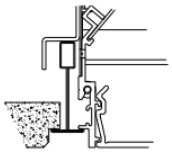
Regressed - (RLP)

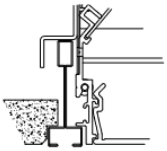
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

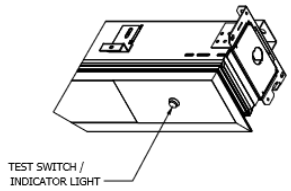

TG
(15/16" Grid)


TG
(9/16" Grid)

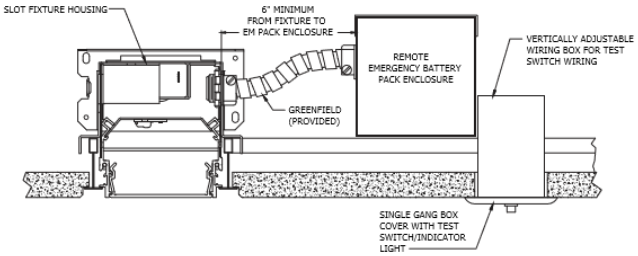

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

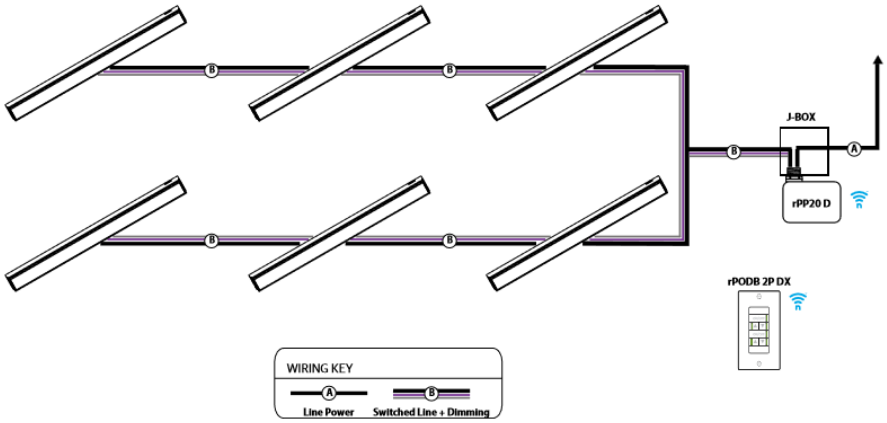
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

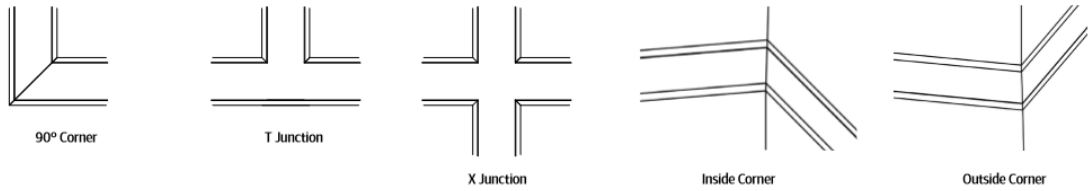


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

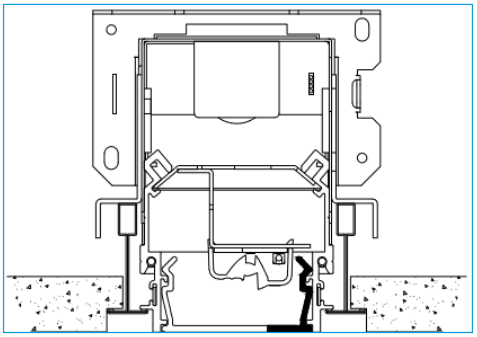
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

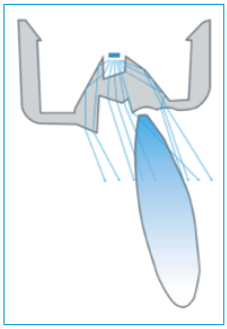
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

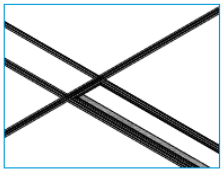
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

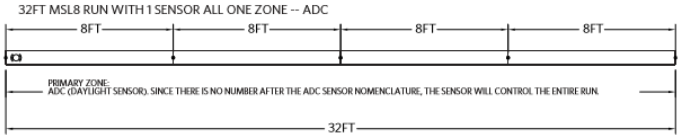




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

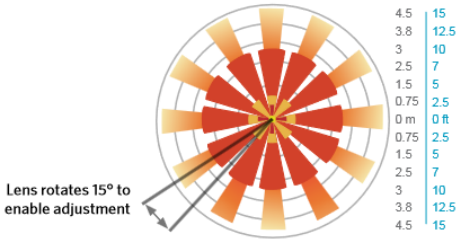
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-14FT10-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	51
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	8'-6" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

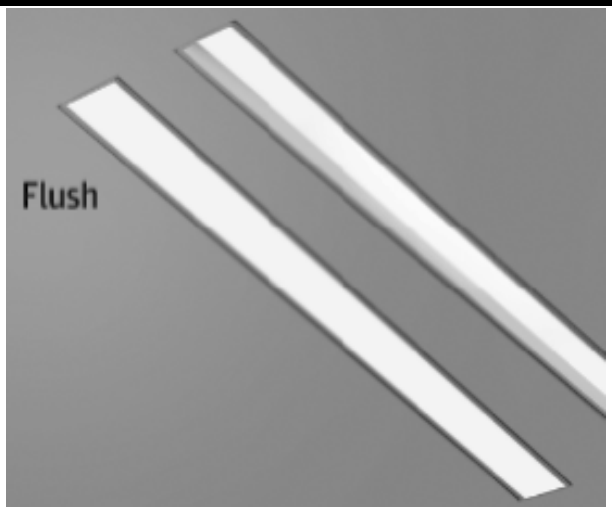
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

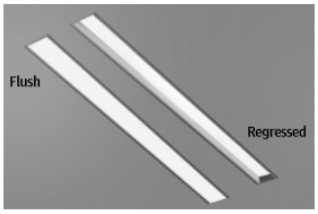
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:

DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

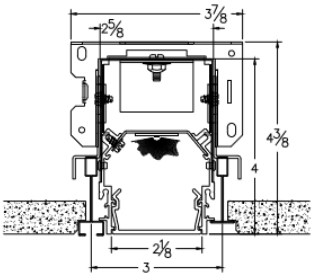
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



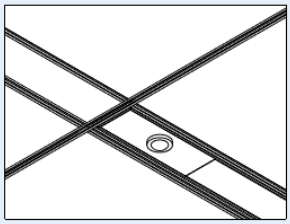
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

				MVOLT		
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD*[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

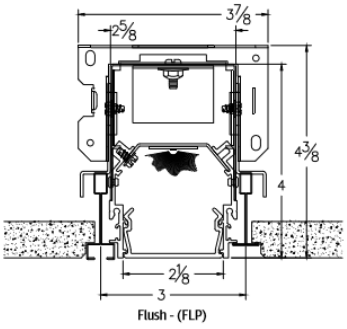
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

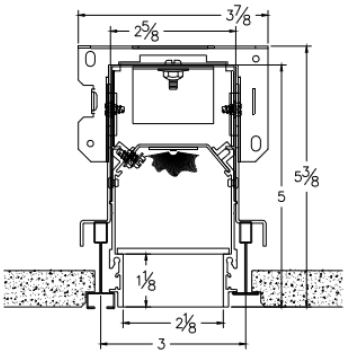
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

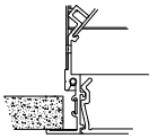


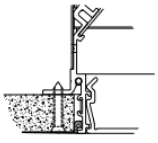
Flush - (FLP)

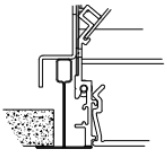


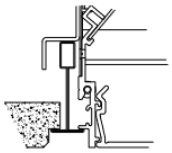
Regressed - (RLP)

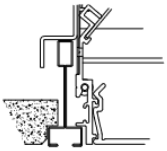
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

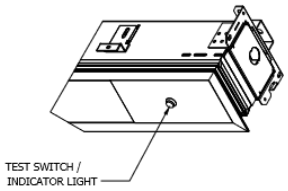

TG
(15/16" Grid)


TG
(9/16" Grid)

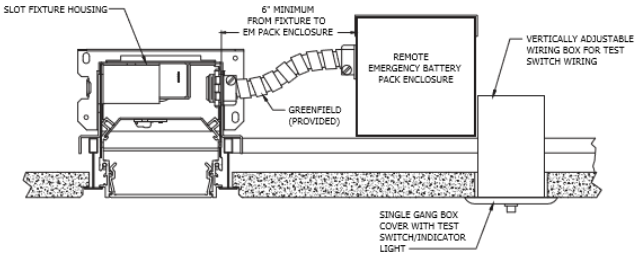

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



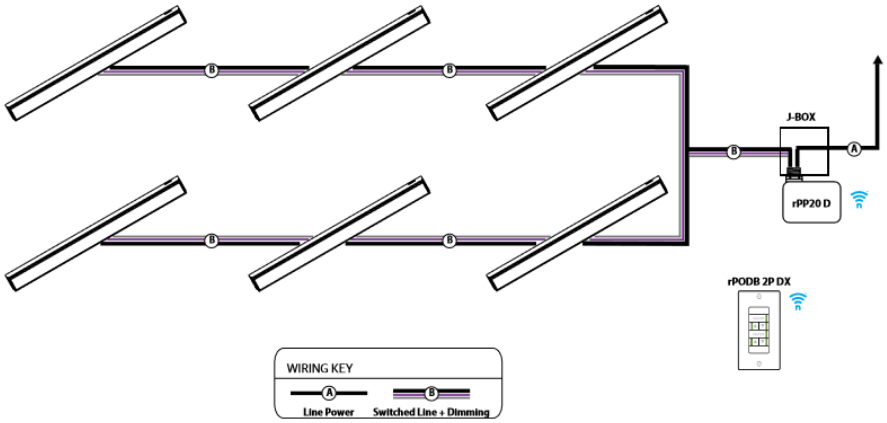
Notes
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

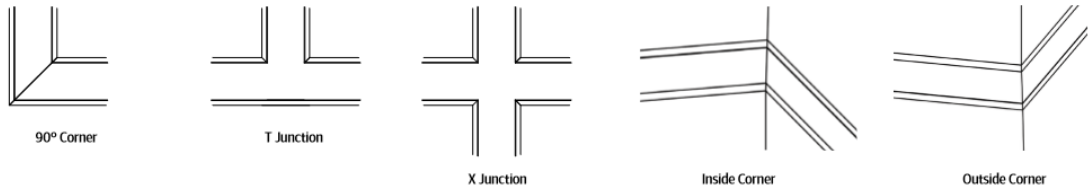


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



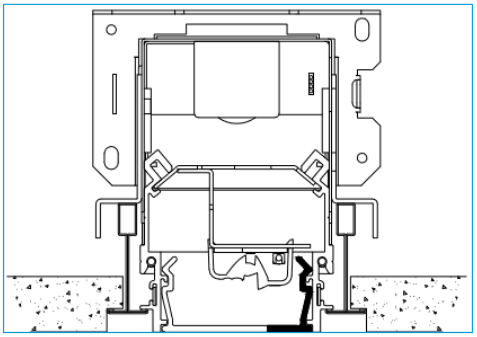
Layout Sketch

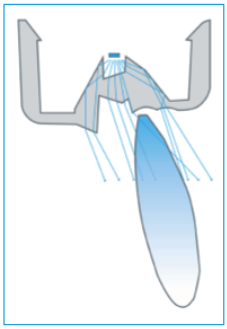
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

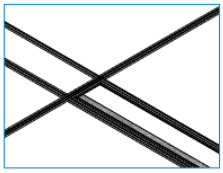
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

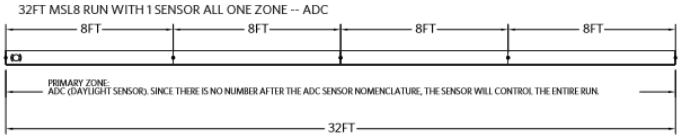




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

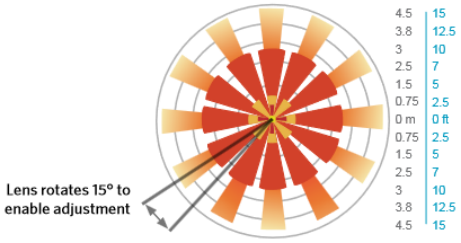
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-24FT07-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	50
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	8'-4" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

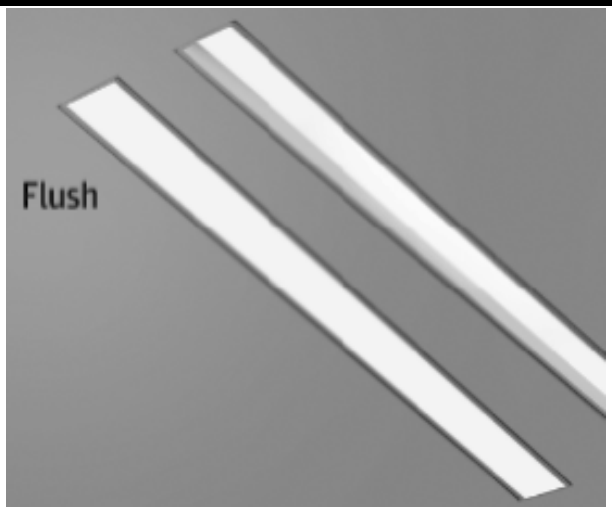
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600LM/FT
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600LM/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

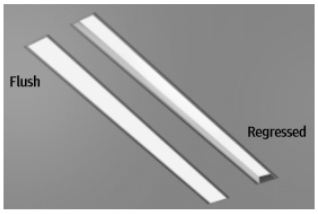
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

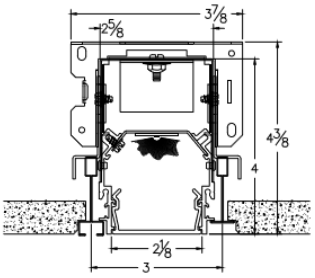
To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Technical Drawing



Flush - (FLP)

Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

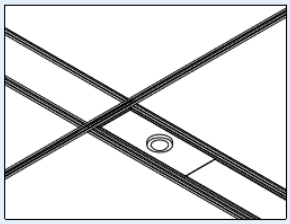
Note: *UGR data available on Page 5*

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

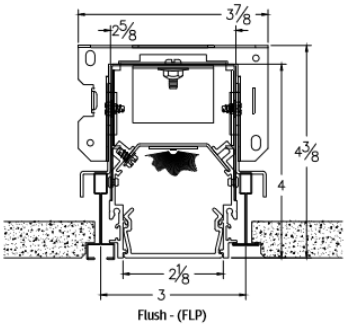
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

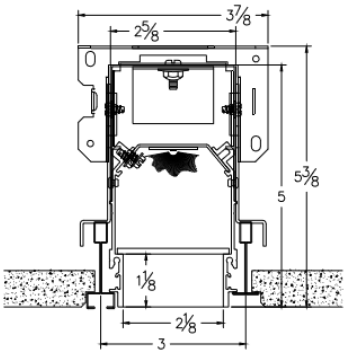
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

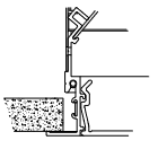


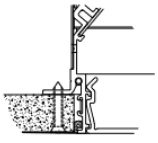
Flush - (FLP)

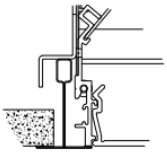


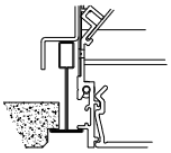
Regressed - (RLP)

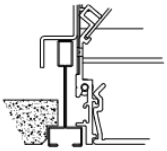
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

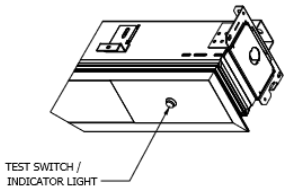

TG
(15/16" Grid)


TG
(9/16" Grid)

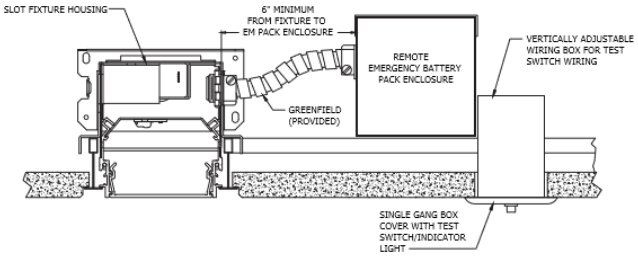

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

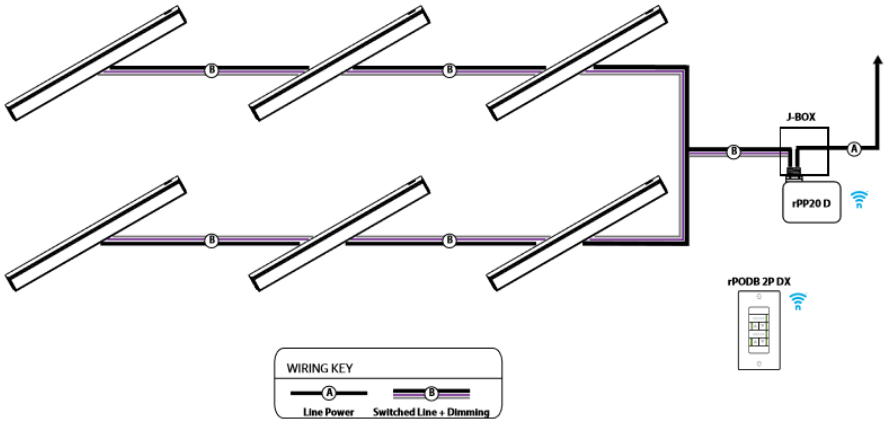
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

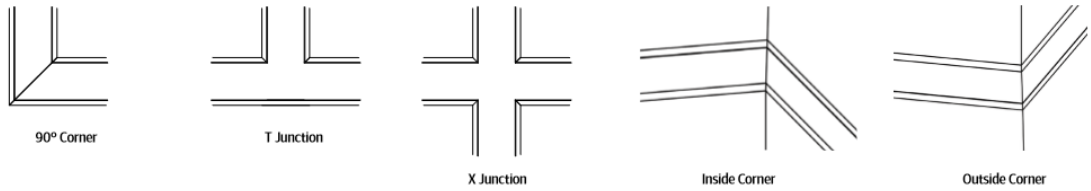


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

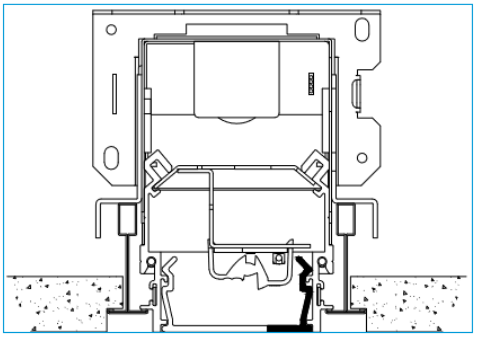
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

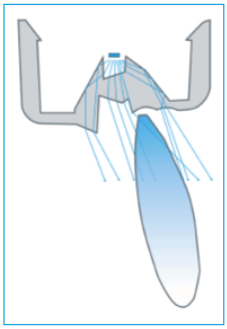
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

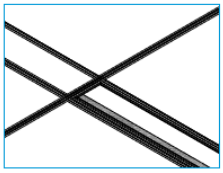
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

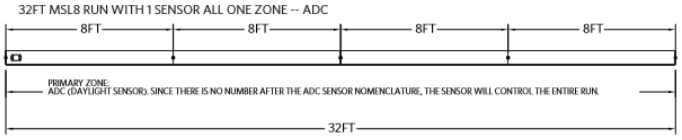




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

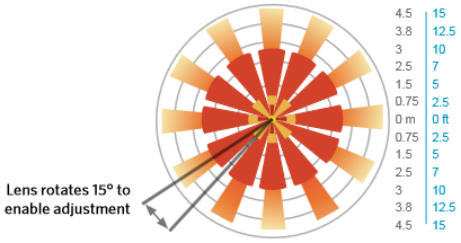
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-15FT04-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	80.5
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	13'-5" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

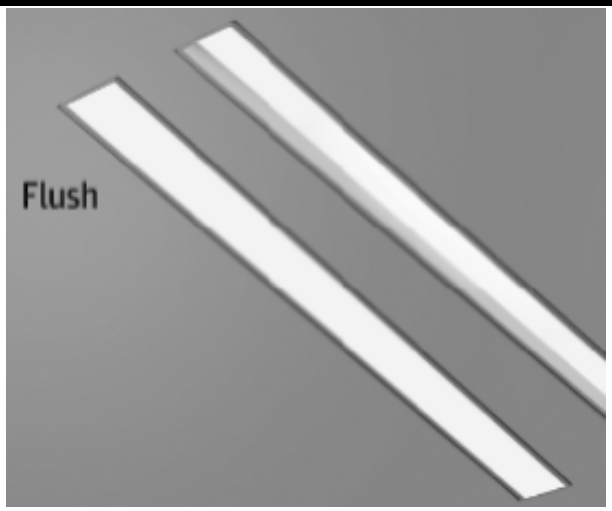
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

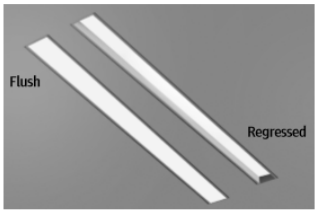
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:

DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

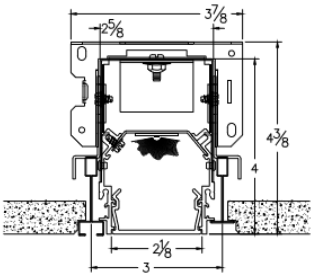
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



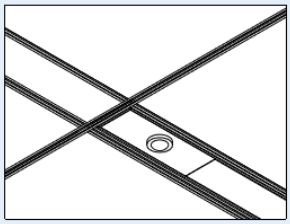
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

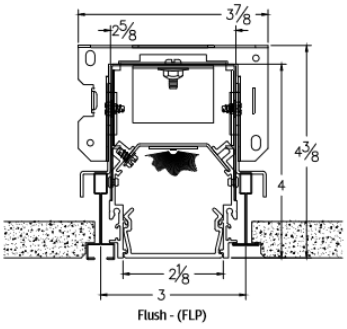
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

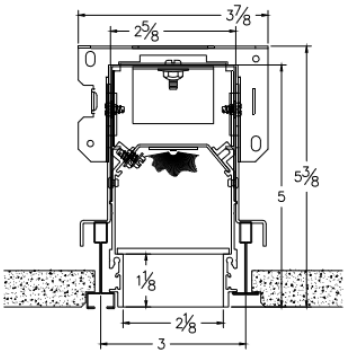
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

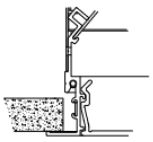


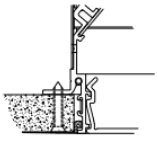
Flush - (FLP)

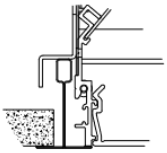


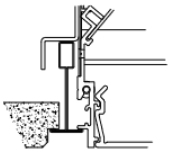
Regressed - (RLP)

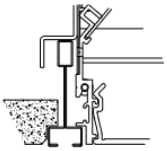
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

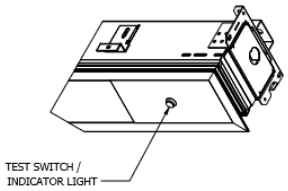

TG
(15/16" Grid)


TG
(9/16" Grid)

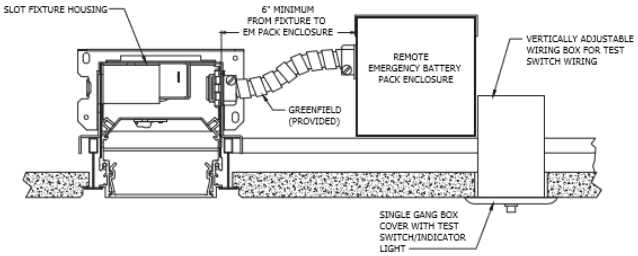

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

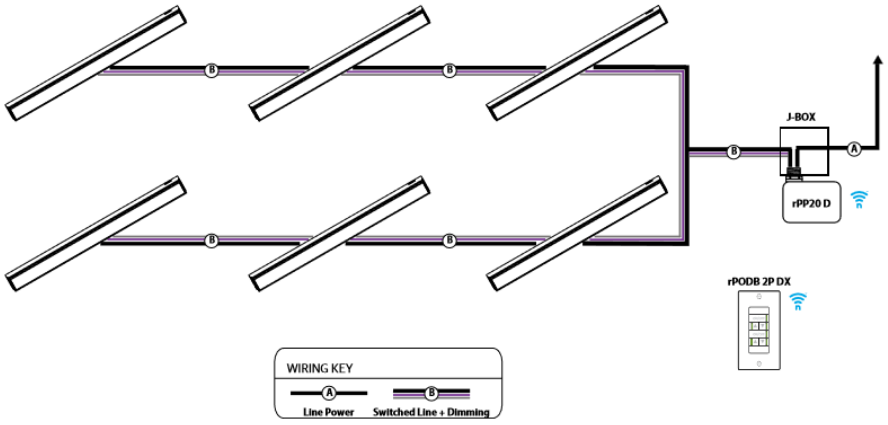
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

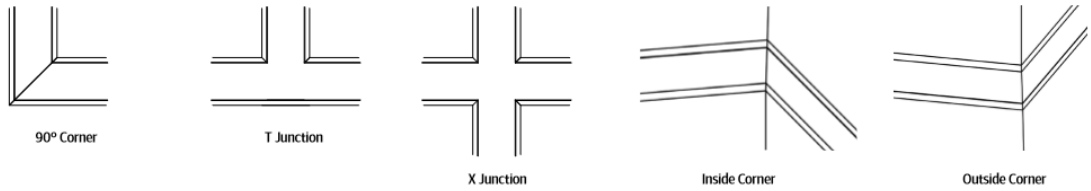


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

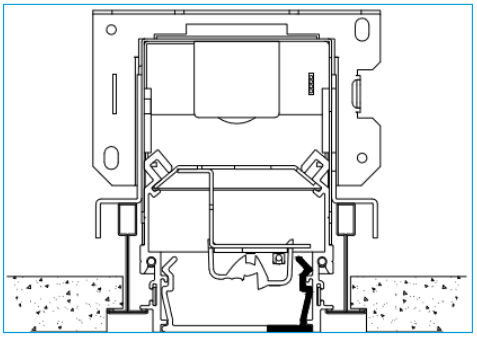
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

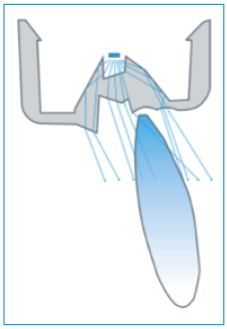
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

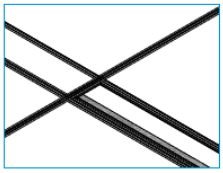
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

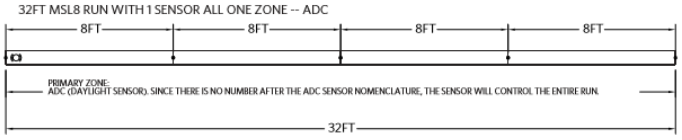




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

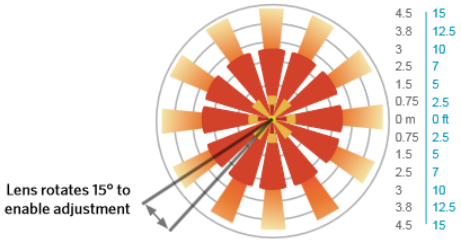
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-2FT10-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	232
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	38'-8" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

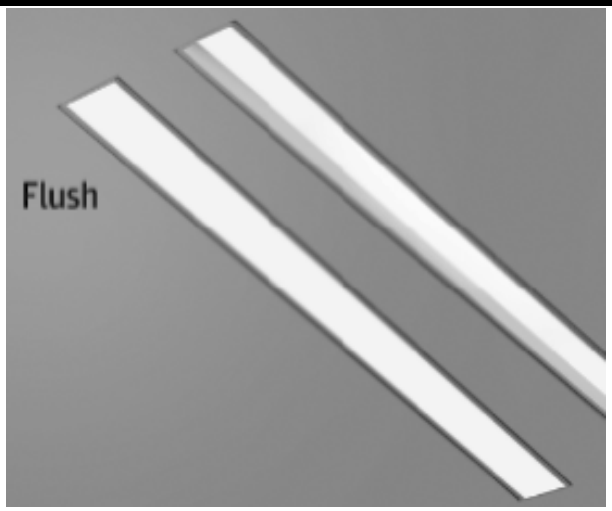
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

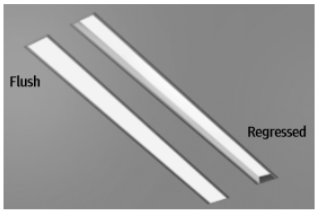
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2' x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1' increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

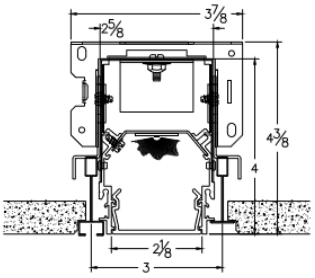
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



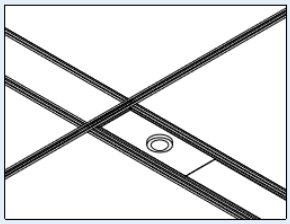
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

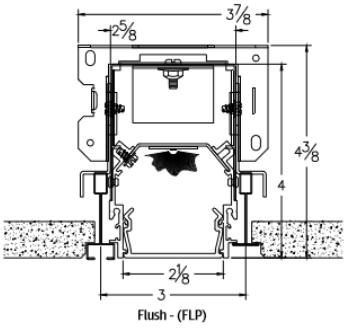
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

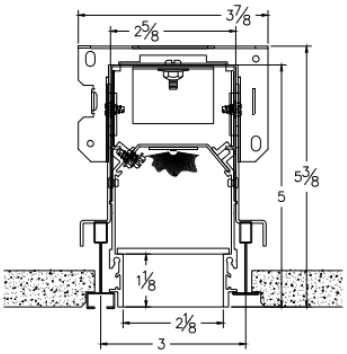
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

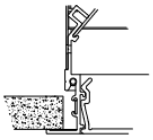


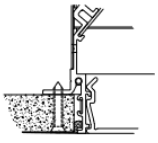
Flush - (FLP)

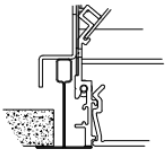


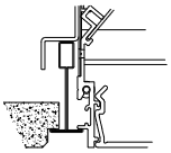
Regressed - (RLP)

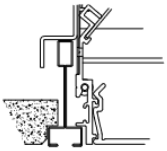
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

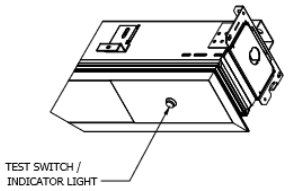

TG
(15/16" Grid)


TG
(9/16" Grid)

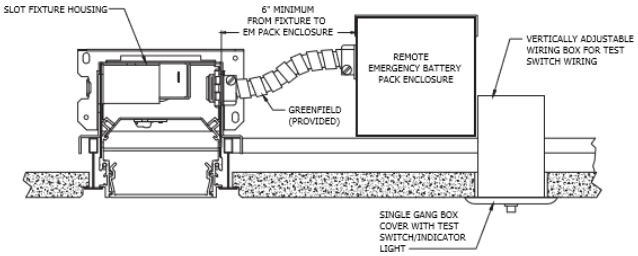

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

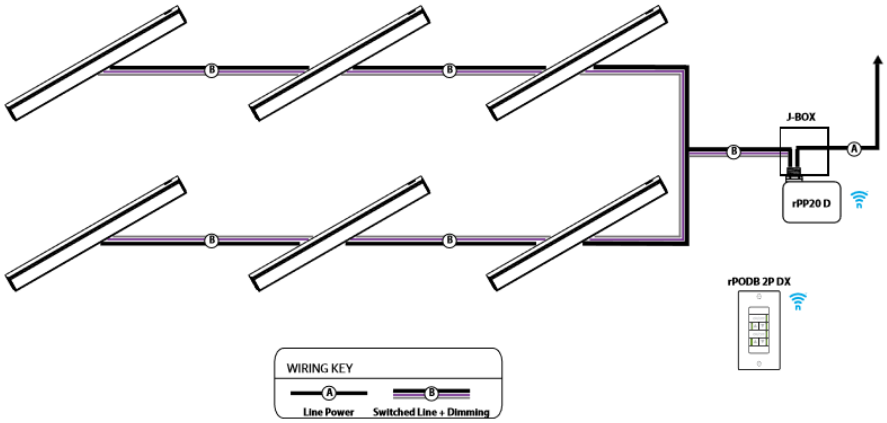
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

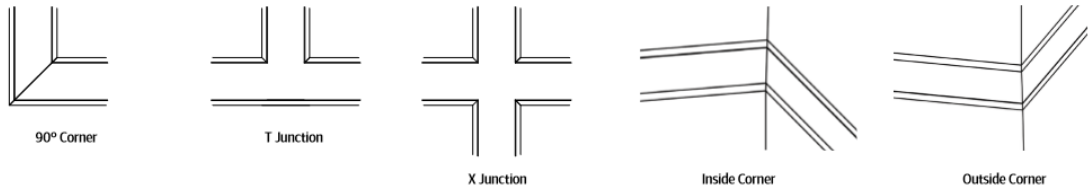


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



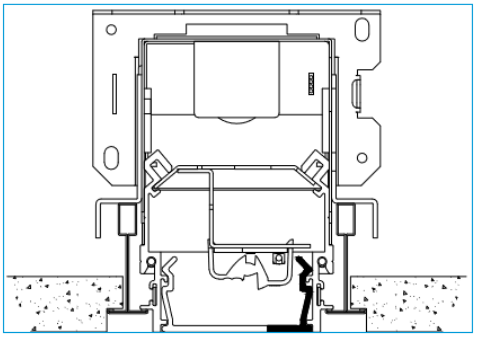
Layout Sketch

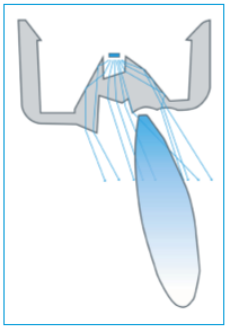
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

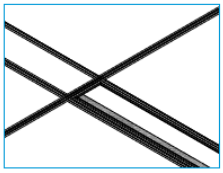
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

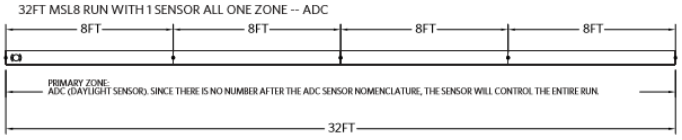




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

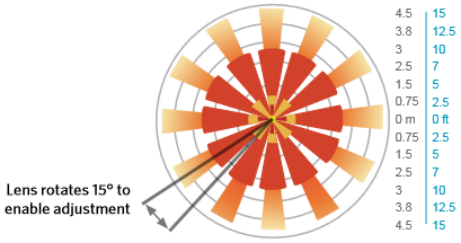
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-21FT11-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	27.5
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	21'-11" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

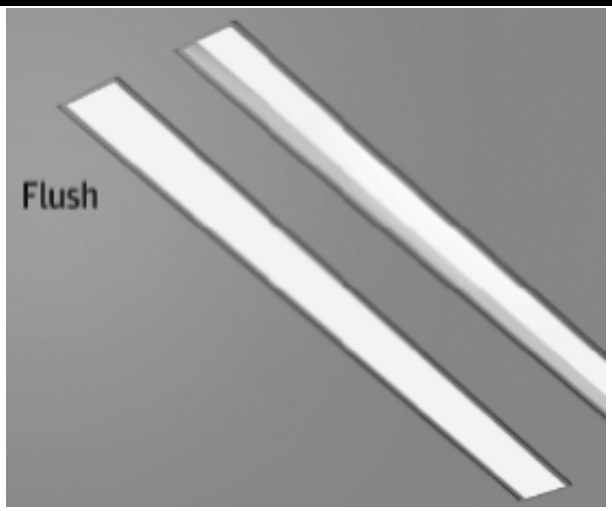
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

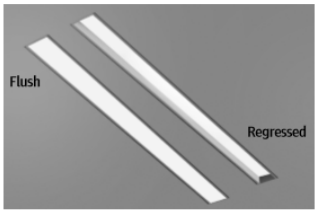
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:

DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

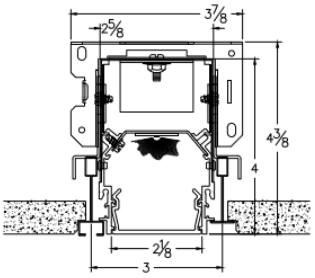
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



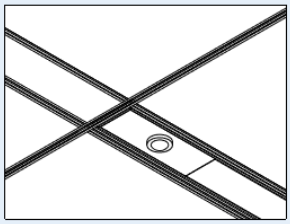
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

MVOLT

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/AMF	Anti-Microbial White (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits
WEC[6]	Entire run on EC

Control Input

(blank)	Non-dim[11]
ZT	0-10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

* Requires longer lead time.

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone, No Sensors
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone, No Sensors
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
SADC[13]	Daylight Dimming Sensor, No Sensors
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Act and/or Build America Buy America Qualified
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

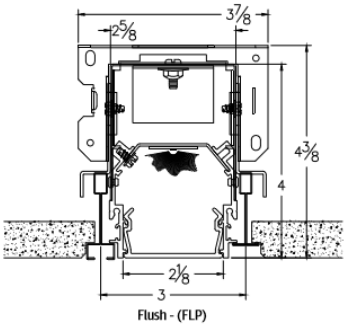
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

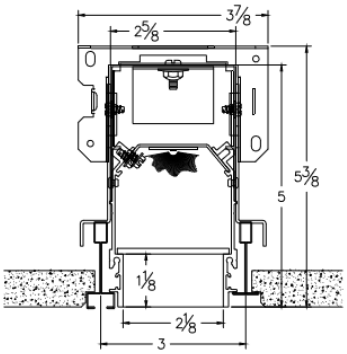
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

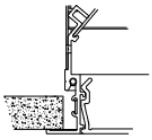


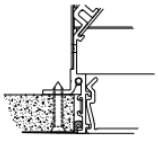
Flush - (FLP)

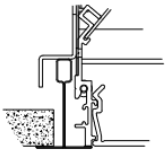


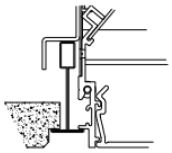
Regressed - (RLP)

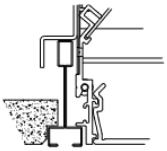
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

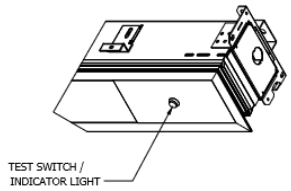

TG
(15/16" Grid)


TG
(9/16" Grid)

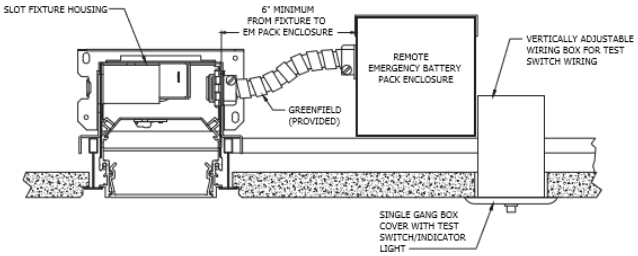

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

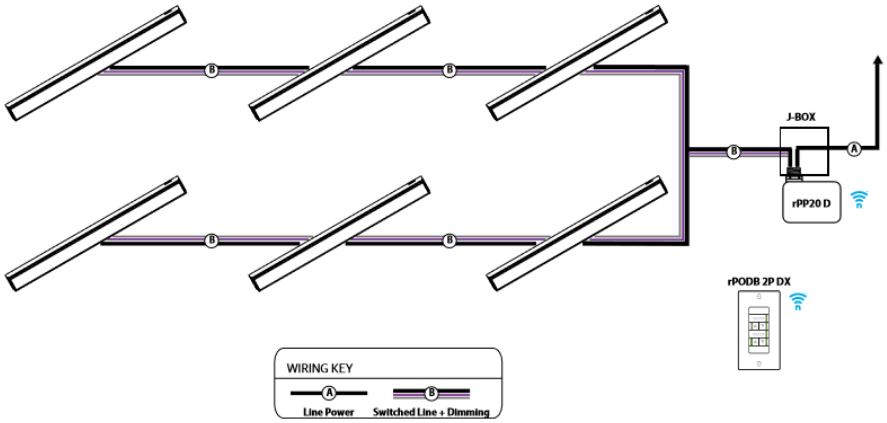
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

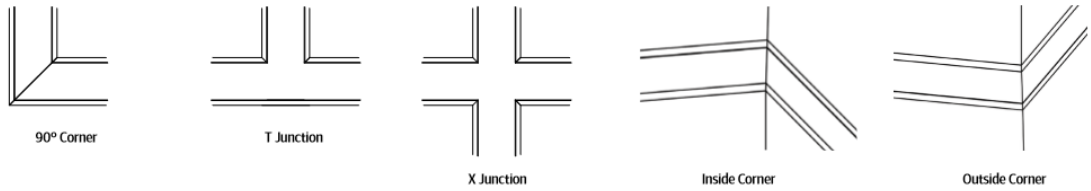


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

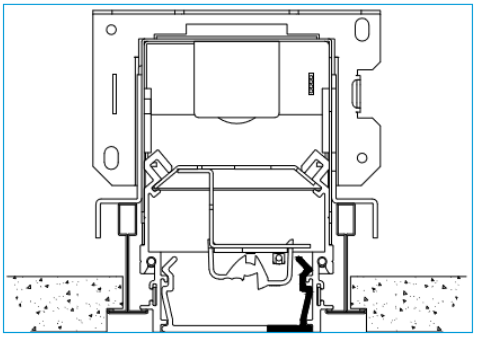
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

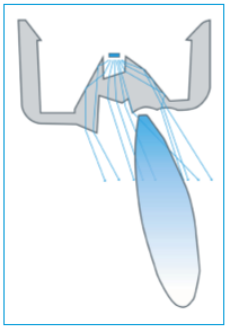
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

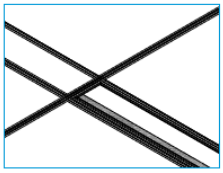
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

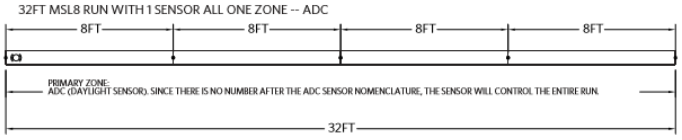




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

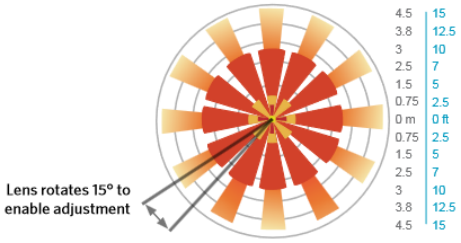
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-3FT00-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	18
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	6'-11" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

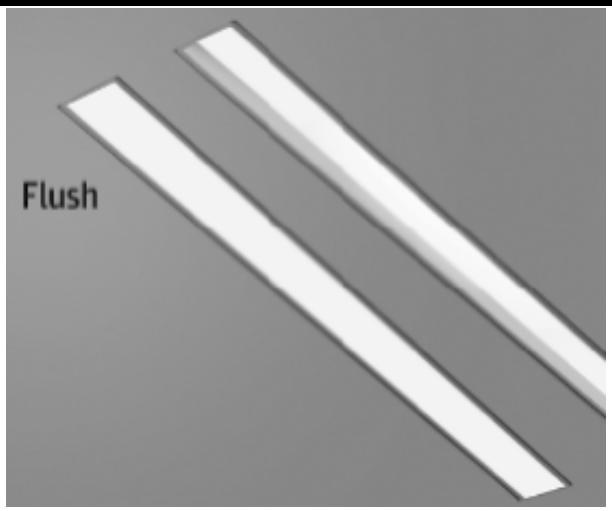
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

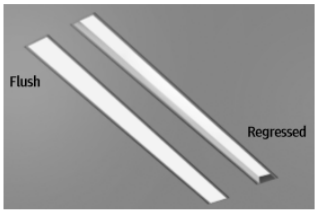
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

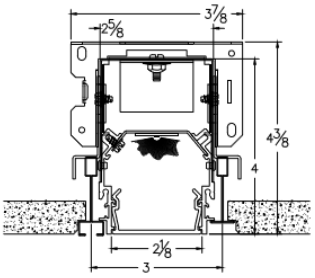
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



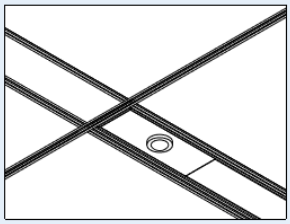
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

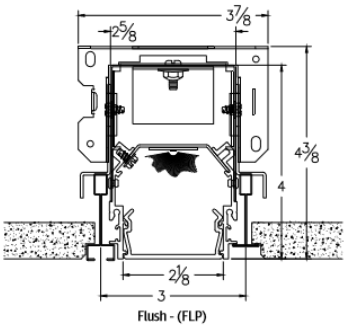
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

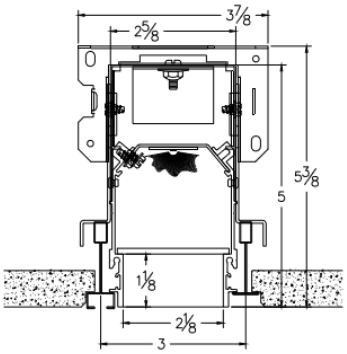
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

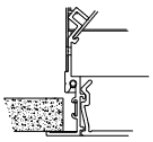


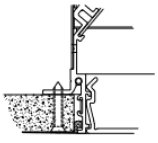
Flush - (FLP)

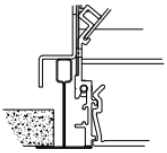


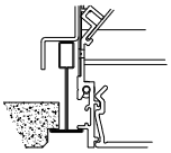
Regressed - (RLP)

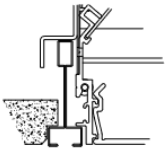
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

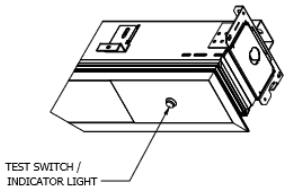

TG
(15/16" Grid)


TG
(9/16" Grid)

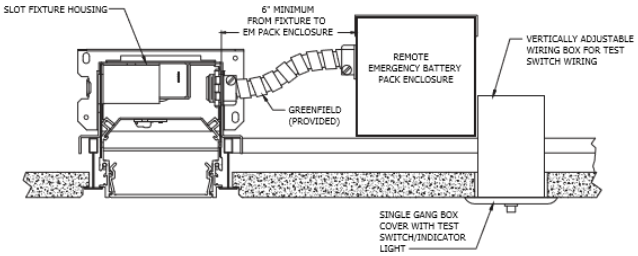

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

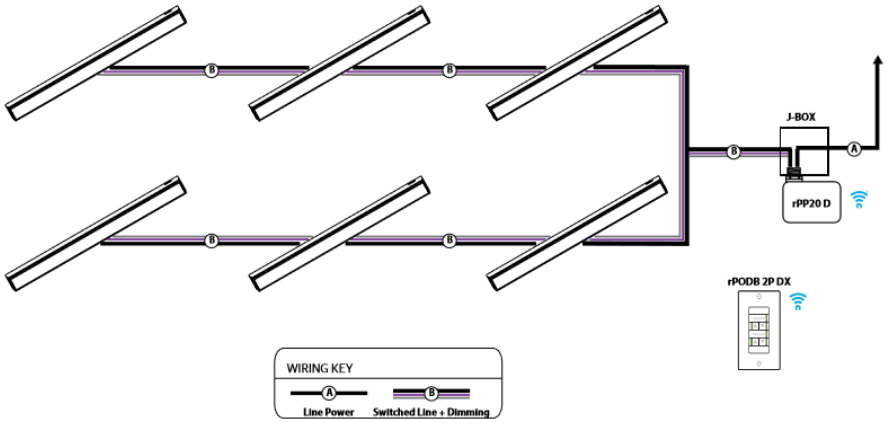
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

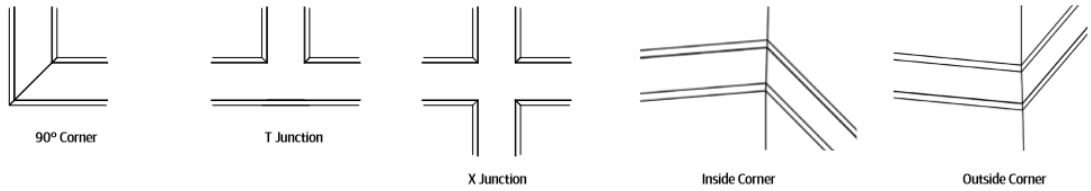


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



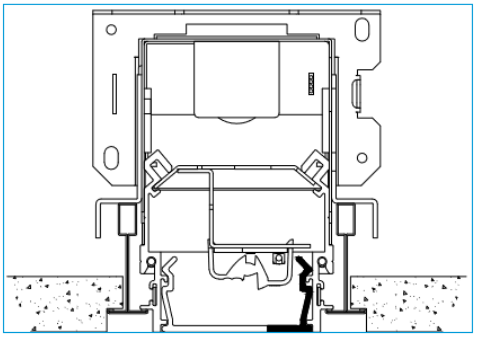
Layout Sketch

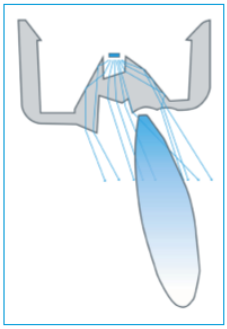
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

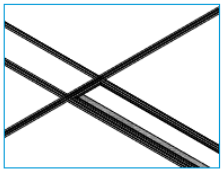
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

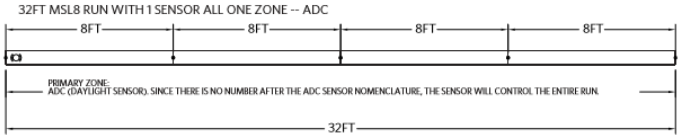




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

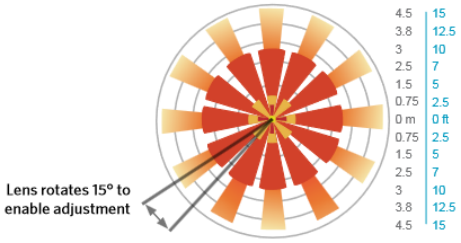
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-23FT10-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	218.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	36'-5" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

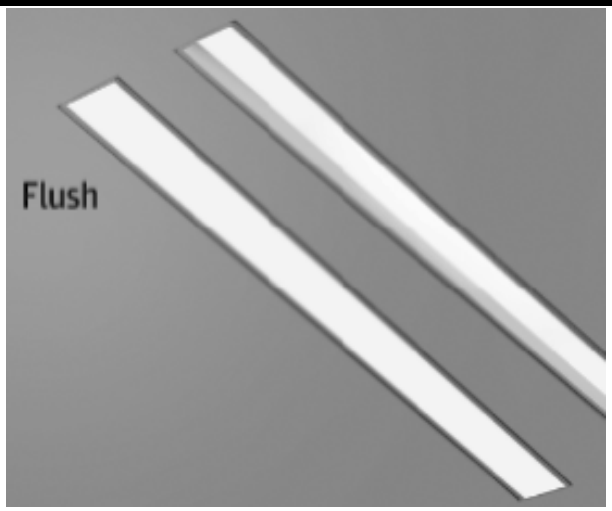
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

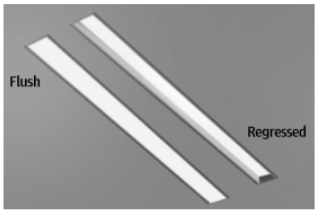
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

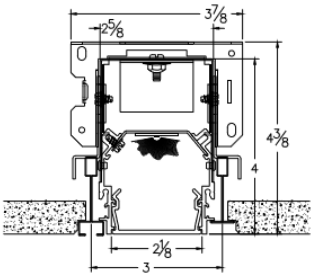
To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Technical Drawing



Flush - (FLP)

Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

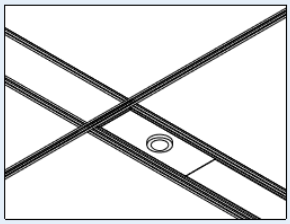
Note: *UGR data available on Page 5*

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**

Series
- SL2L — Slot 2 LED Linear Recessed

Linear Length Plan
- LOP — Linear Optimized Plan

Total Run Length
- 2FT 2'
- 3FT 3'
- 4FT 4'
- 5FT 5'
- 6FT 6'
- 7FT 7'
- 8FT 8'
- _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
- _FT **Specify continuous linear feet in 1 foot increments

Fixture Style
- RLP[1,3] Regressed Lens
- FLP[2] Flush Lens

Ceiling Trim
- FL[4] 5/8" Flange(sheetrock)
- FLINB[21,22] 5/8" Flange (sheetrock) Install From Below
- TG 9/16" or 15/16" Flat or Inverted Tee
- GB[4] Trimless (sheetrock)
- WFL Perimeter Mount, 5/8" Flange (Sheetrock)
- WTG 9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering
- 80CRI 80 CRI
- 90CRI 90 CRI

		MVOLT			
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**

Direct LED Color Temp
- 27K* 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K* 5000K

Direct LED Light Output
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- _LMF* [9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution
- (blank) Standard Distribution
- WW [5] Wall Wash

Minimum Dimming Level
- NODIM Non - Dim
- MIN1 Constant current, dimming to 1%
- DARK Constant current, dimming to 0.1%
- MIN10 [15] Constant current, dimming to 10%

Voltage
- 120 120V
- 277 277V
- 347 [7] 347V

Finish
- (blank) White (satin)
- xxx/BLKT Black (satin)
- xxx/SLVT Silver (satin)
- xxx/AMF Anti-Microbial White (satin)
- xxx/RALTBD RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options
- (blank) No Emergency
- _E10WLCP [8] Number of 4ft Emergency Section(s) with battery pack
- _EC [10] # of Emergency Circuits
- WEC [6] Entire run on EC

Control Input	**Primary Sensor** [12]	**Secondary Sensor** [12]	**Tertiary Zone**	**Options**

Control Input
- (blank) Non-dim [11]
- ZT 0 10V
- NLIGHT nLight enabled
- NLTAIR2 [17] nLight Air (Wireless Enabled)
- ECOD [8, 16] Lutron Hi-Lume digital driver
- DALI [19] Dali

* Requires longer lead time.

Primary Sensor [12]
- (blank) Single Zone, No Sensor
- NS Multi-zone, No Sensor Main Zone, No Sensors
- PDT [13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
- ADC [13] Daylight Dimming Sensor
- API [14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
- APD [14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor [12]
- (blank) No additional zones/sensors
- SNS Multi-zone, with no sensor in secondary zone, No Sensors
- SPDT [13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
- SADC [13] Daylight Dimming Sensor, No Sensors
- SAPI [14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
- SAPD [14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone
- (blank) No additional zones/sensors
- TNS Multi-zone, with no sensor in tertiary zone

Options
- CP [18] Chicago Plenum
- BAA Buy America(n) Act and/or Build America Buy America Qualified
- WL [3,9,20] Wet Location Listing
- DPL [20] Damp Location Listing
- PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes
1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

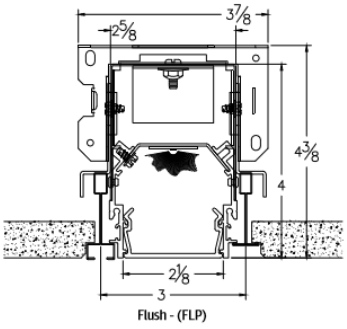
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

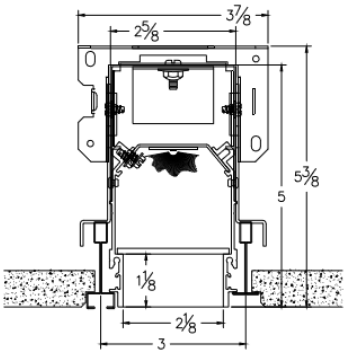
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

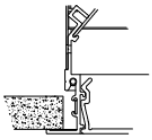


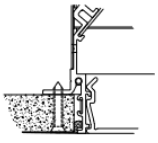
Flush - (FLP)

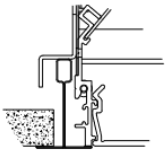


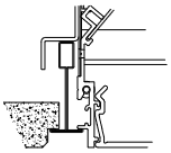
Regressed - (RLP)

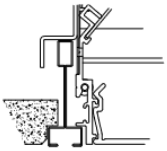
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

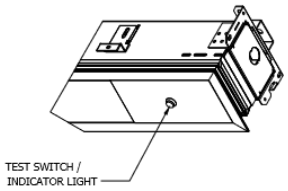

TG
(15/16" Grid)


TG
(9/16" Grid)

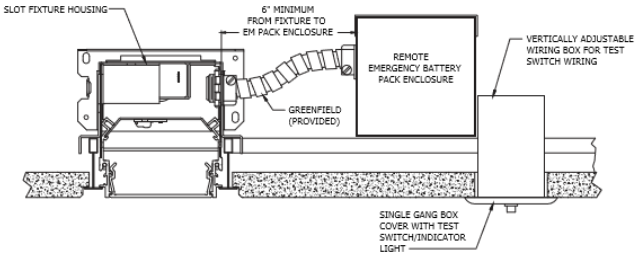

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

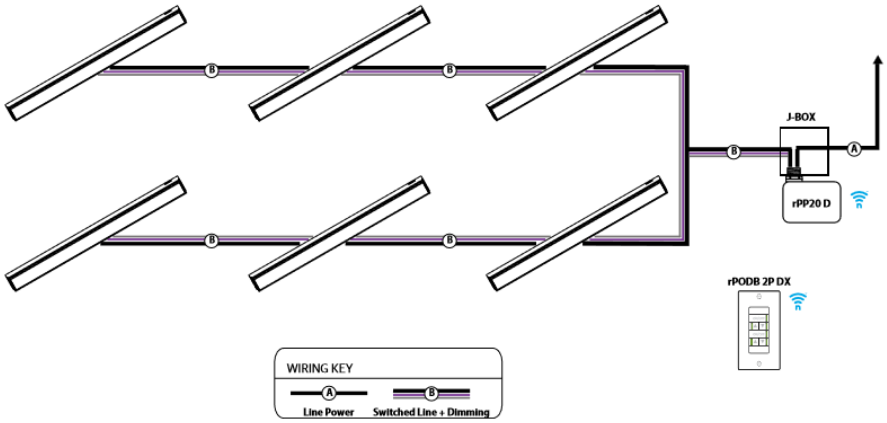
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

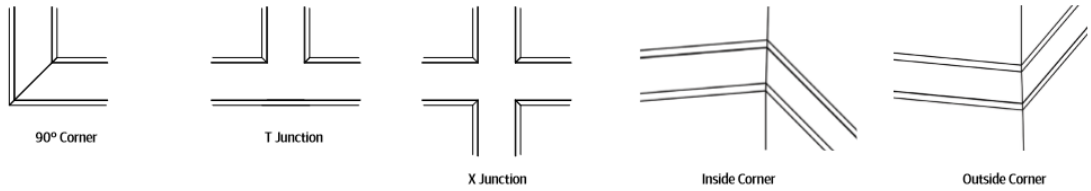


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

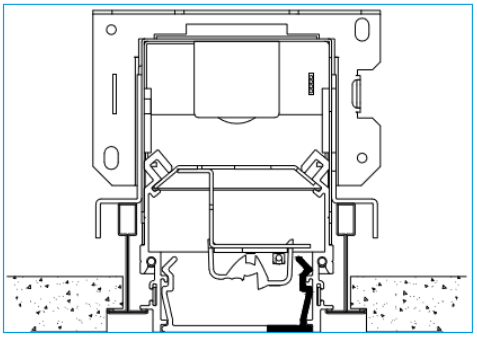
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

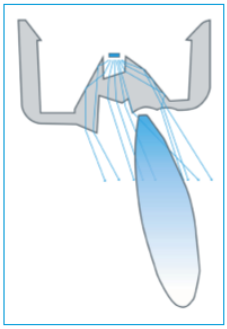
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

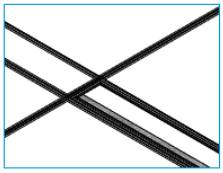
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

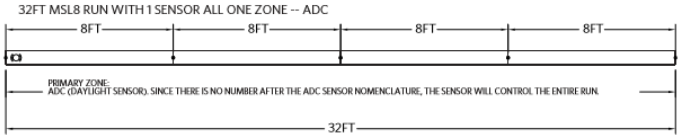




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

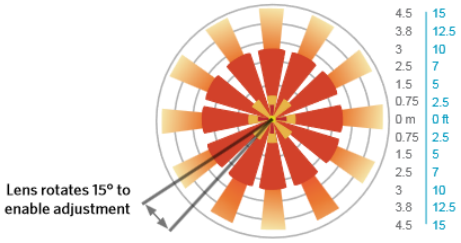
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-6FT9-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	139.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	23’-3” x 3” x 3 3/8”
FINISH	White Powder Coat
RATING	IP
LISTING	UL

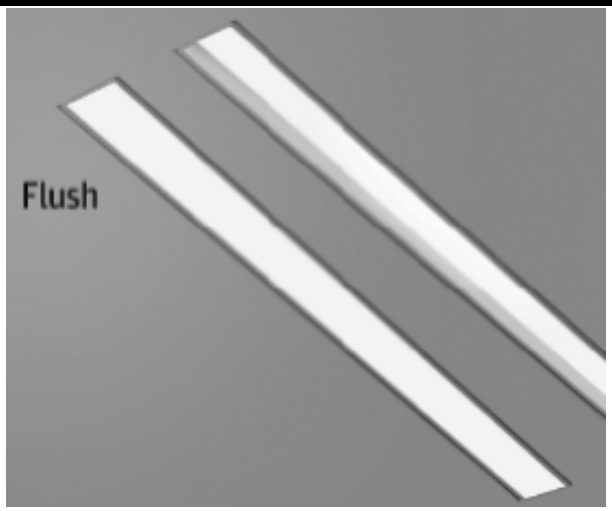
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

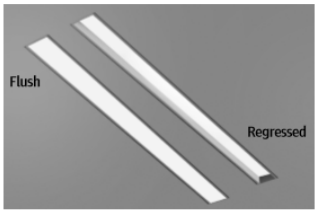
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

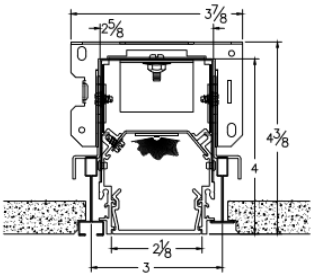
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



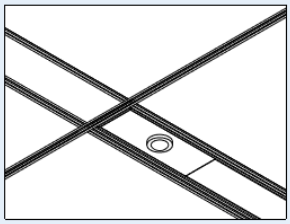
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

MVOLT

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/AMF	Anti-Microbial White (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits
WEC[6]	Entire run on EC

Control Input

(blank)	Non-dim[11]
ZT	0-10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

* Requires longer lead time.

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone, No Sensors
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone, No Sensors
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
SADC[13]	Daylight Dimming Sensor, No Sensors
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Act and/or Build America Buy America Qualified
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

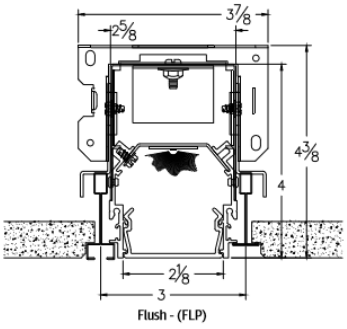
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

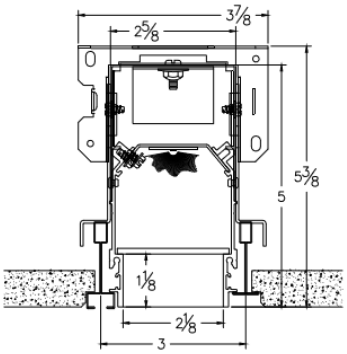
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

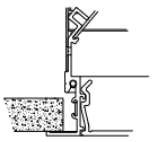


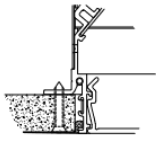
Flush - (FLP)

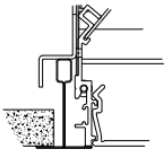


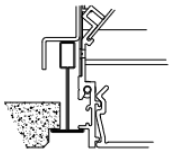
Regressed - (RLP)

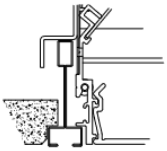
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

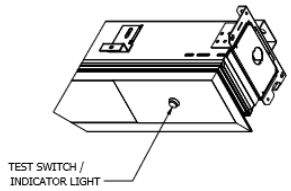

TG
(15/16" Grid)


TG
(9/16" Grid)

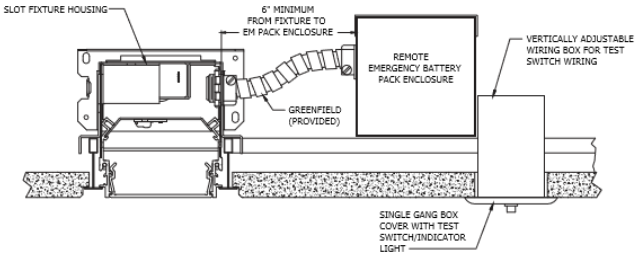

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

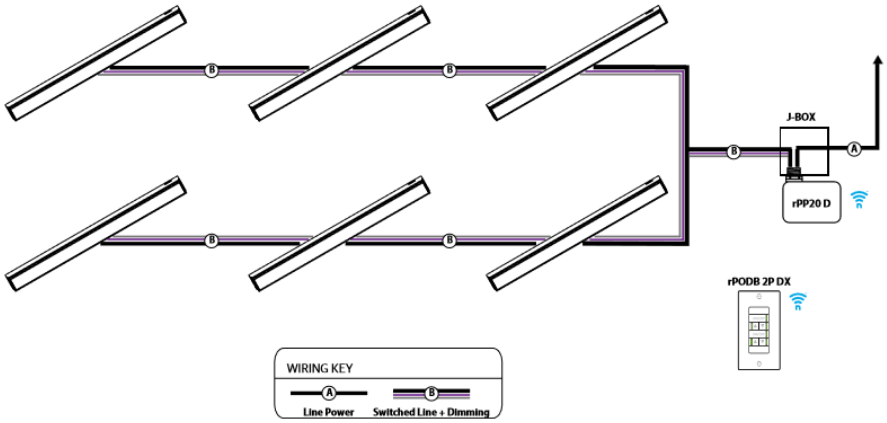
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

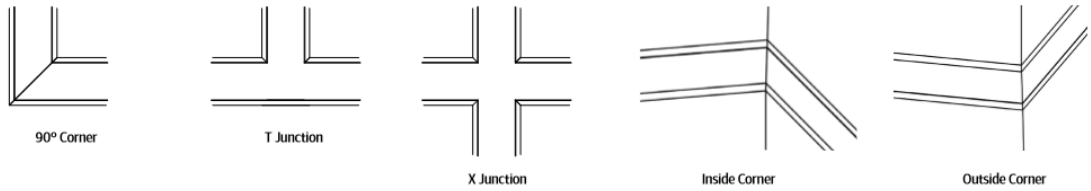


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

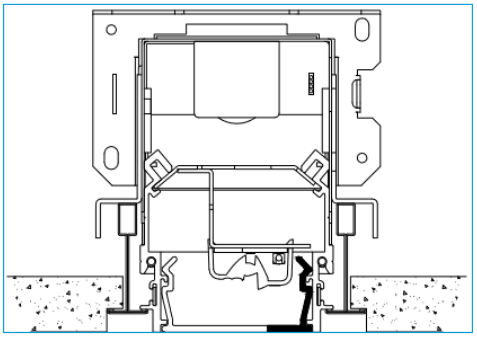
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

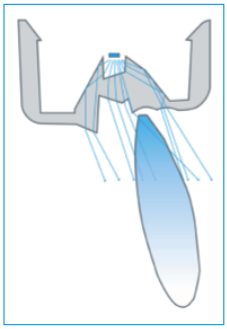
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

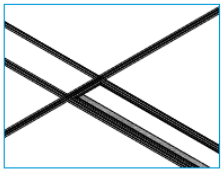
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

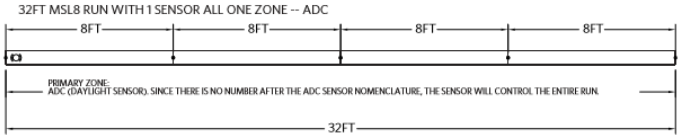




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

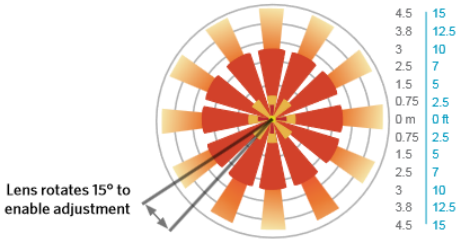
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-32FT00-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	11
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	1'-10" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

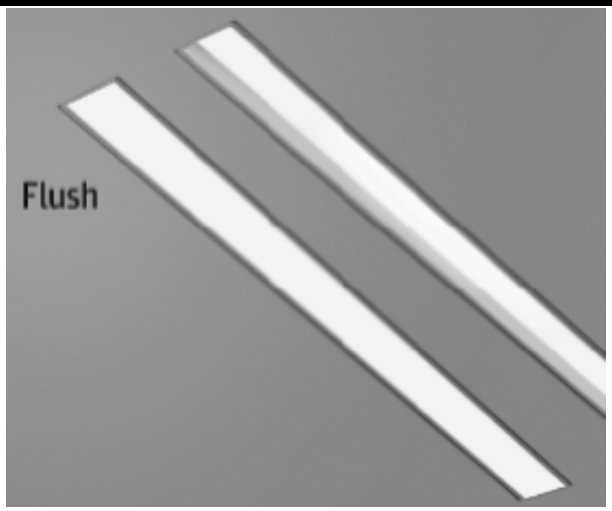
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

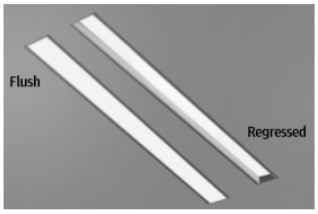
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2' x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1' increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

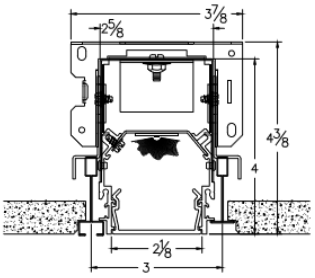
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



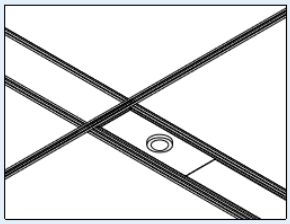
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

MVOLT

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/AMF	Anti-Microbial White (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits
WEC[6]	Entire run on EC

Control Input

(blank)	Non-dim[11]
ZT	0-10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

* Requires longer lead time.

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone, No Sensors
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone, No Sensors
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
SADC[13]	Daylight Dimming Sensor, No Sensors
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Act and/or Build America Buy America Qualified
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

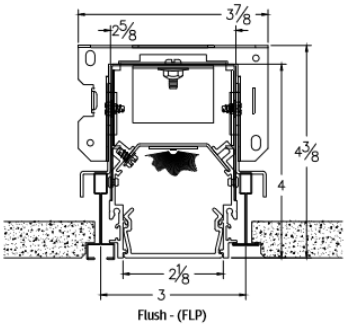
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

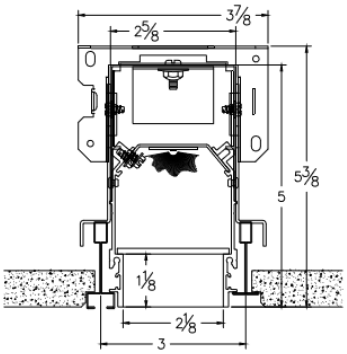
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

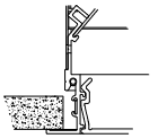


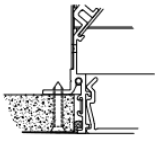
Flush - (FLP)

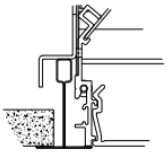


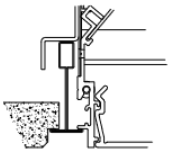
Regressed - (RLP)

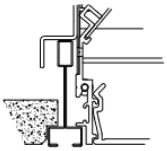
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

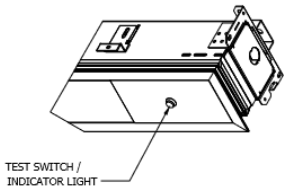

TG
(15/16" Grid)


TG
(9/16" Grid)

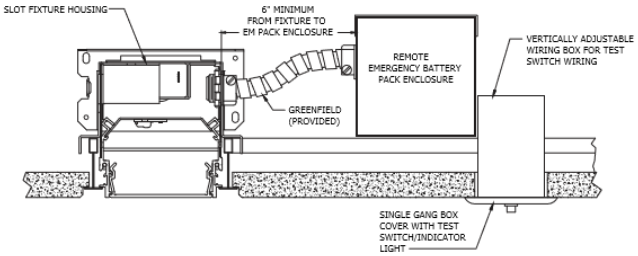

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

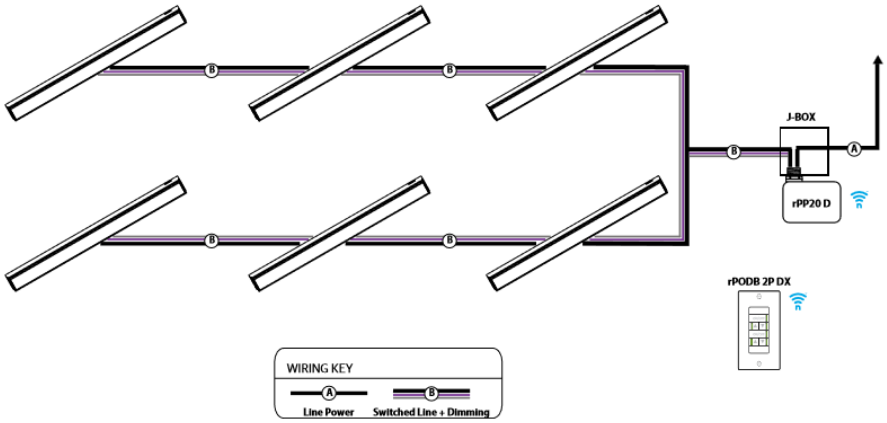
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

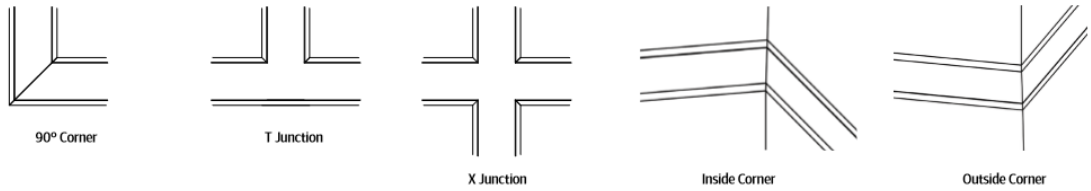


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

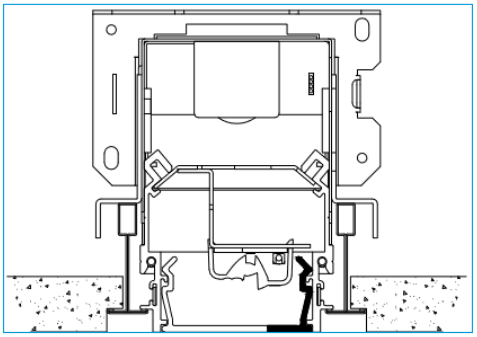
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

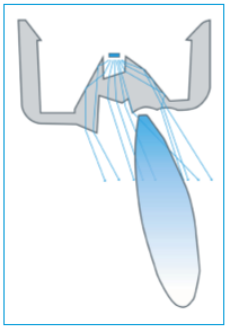
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

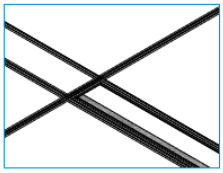
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

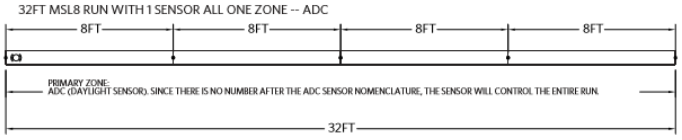




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

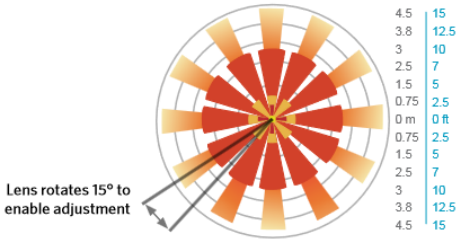
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-02FT11-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	139.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	23'-3" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

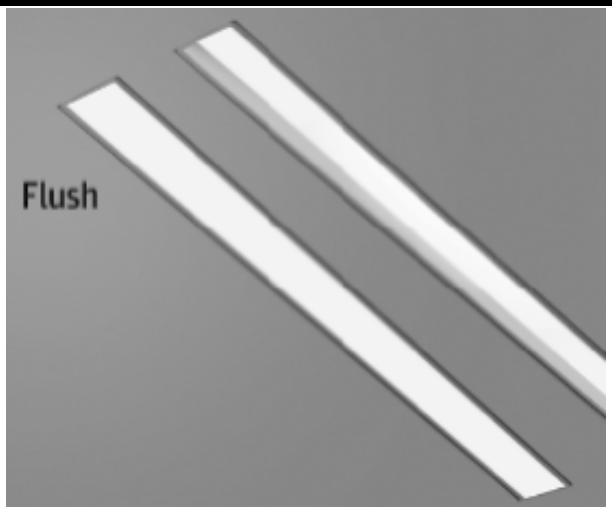
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

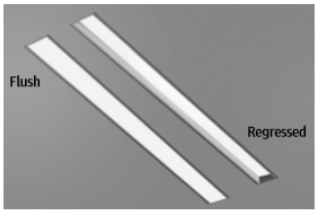
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2' x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1' increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

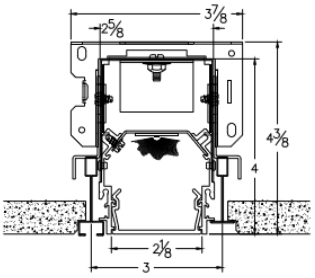
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



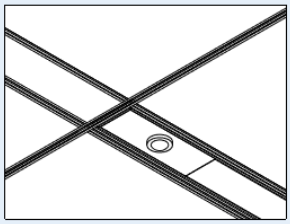
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	Linear Length Plan	Total Run Length	Fixture Style	Ceiling Trim	Direct Light Source Color Rendering

Series
- SL2L — Slot 2 LED Linear Recessed

Linear Length Plan
- LOP — Linear Optimized Plan

Total Run Length
- 2FT 2'
- 3FT 3'
- 4FT 4'
- 5FT 5'
- 6FT 6'
- 7FT 7'
- 8FT 8'
- _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
- _FT **Specify continuous linear feet in 1 foot increments

Fixture Style
- RLP[1,3] Regressed Lens
- FLP[2] Flush Lens

Ceiling Trim
- FL[4] 5/8" Flange(sheetrock)
- FLINB[21,22] 5/8" Flange (sheetrock) Install From Below
- TG 9/16" or 15/16" Flat or Inverted Tee
- GB[4] Trimless (sheetrock)
- WFL Perimeter Mount, 5/8" Flange (Sheetrock)
- WTG 9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering
- 80CRI 80 CRI
- 90CRI 90 CRI

				MVOLT		
Direct LED Color Temp	Direct LED Light Output	Direct Distribution	Minimum Dimming Level	Voltage	Finish	Emergency Options

Direct LED Color Temp
- 27K* 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K* 5000K

Direct LED Light Output
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- _LMF* [9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution
- (blank) Standard Distribution
- WW[5] Wall Wash

Minimum Dimming Level
- NODIM Non - Dim
- MIN1 Constant current, dimming to 1%
- DARK Constant current, dimming to 0.1%
- MIN10[15] Constant current, dimming to 10%

Voltage
- 120 120V
- 277 277V
- 347[7] 347V

Finish
- (blank) White (satin)
- xxx/BLKT Black (satin)
- xxx/SLVT Silver (satin)
- xxx/AMF Anti-Microbial White (satin)
- xxx/RALTBD RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options
- (blank) No Emergency
- _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack
- _EC[10] # of Emergency Circuits
- WEC[6] Entire run on EC

Control Input	Primary Sensor[12]	Secondary Sensor[12]	Tertiary Zone	Options

Control Input
- (blank) Non-dim[11]
- ZT 0 10V
- NLIGHT nLight enabled
- NLTAIR2[17] nLight Air (Wireless Enabled)
- ECOD[8,16] Lutron Hi-Lume digital driver
- DALI[19] Dali

Primary Sensor[12]
- (blank) Single Zone, No Sensor
- NS Multi-zone, No Sensor Main Zone, No Sensors
- PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
- ADC[13] Daylight Dimming Sensor
- API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
- APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]
- (blank) No additional zones/sensors
- SNS Multi-zone, with no sensor in secondary zone, No Sensors
- SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
- SADC[13] Daylight Dimming Sensor, No Sensors
- SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
- SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone
- (blank) No additional zones/sensors
- TNS Multi-zone, with no sensor in tertiary zone

Options
- CP[18] Chicago Plenum
- BAA Buy America(n) Act and/or Build America Buy America Qualified
- WL[3,9,20] Wet Location Listing
- DPL[20] Damp Location Listing
- PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes
1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

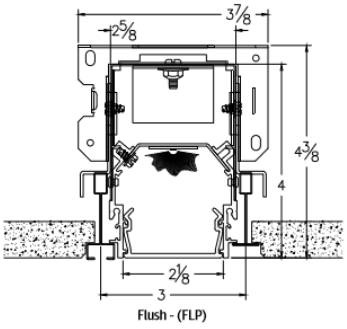
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

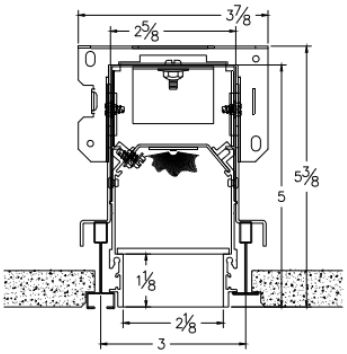
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

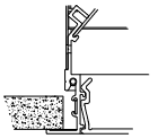


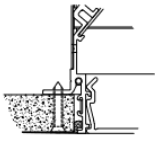
Flush - (FLP)

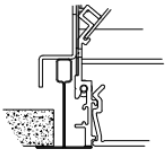


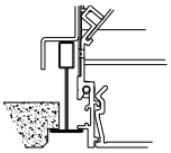
Regressed - (RLP)

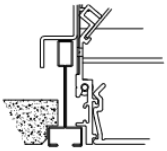
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

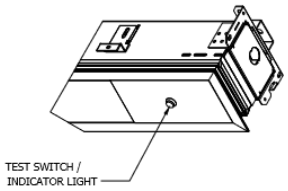

TG
(15/16" Grid)


TG
(9/16" Grid)

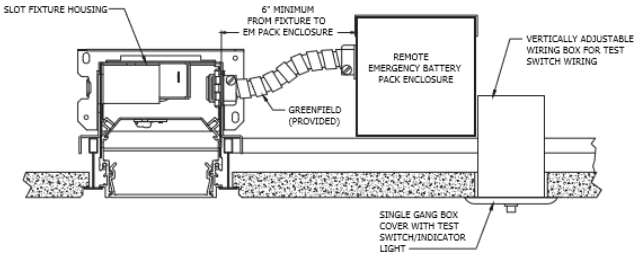

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



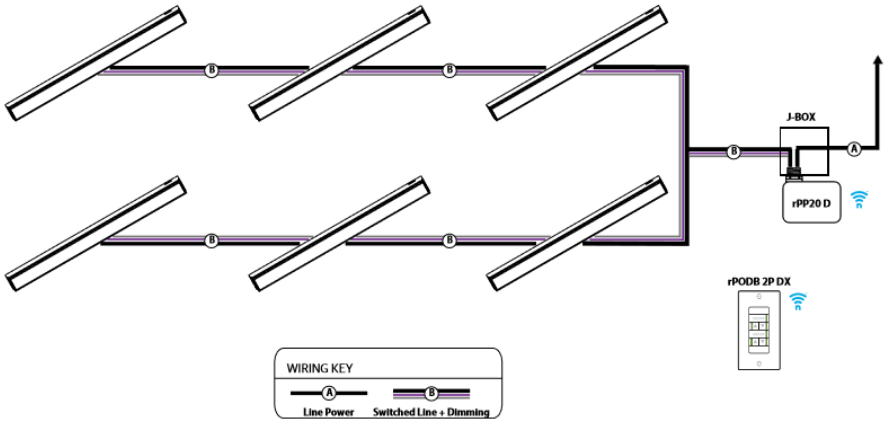
Notes
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

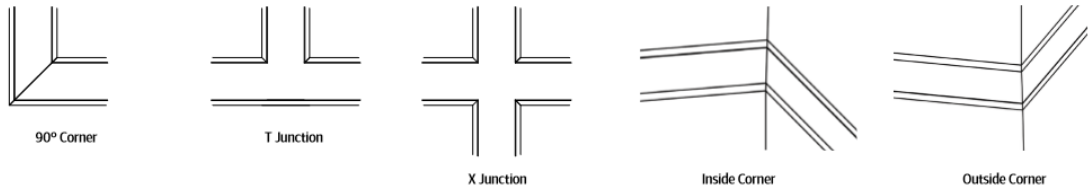


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

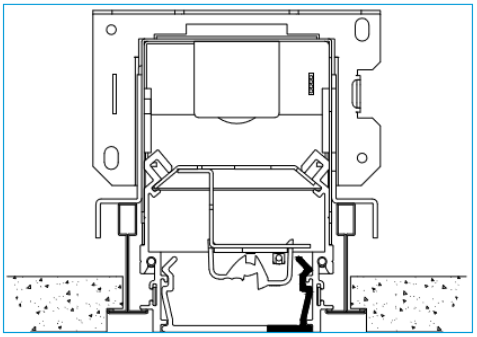
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

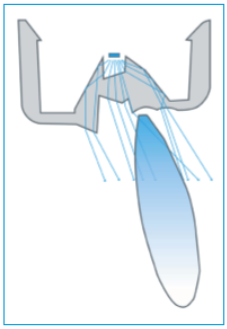
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

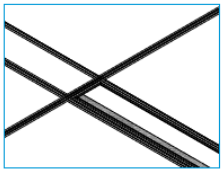
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

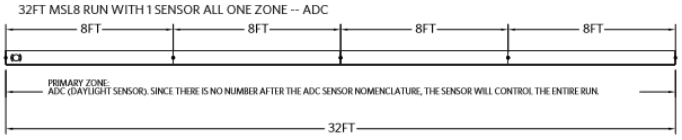




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

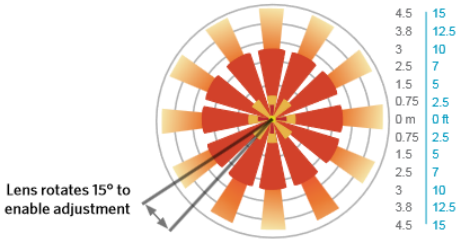
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-05FT10-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	110.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	18'-5" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

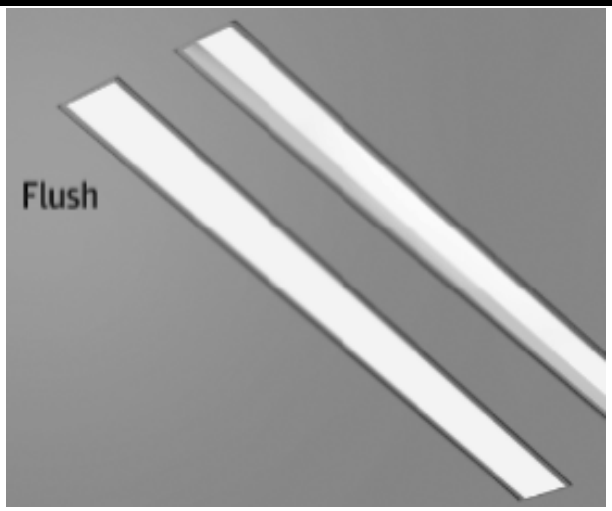
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	300K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 300K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

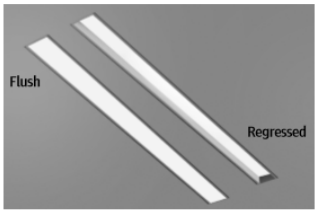
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

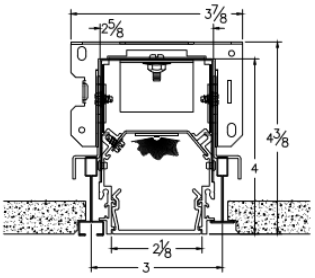
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



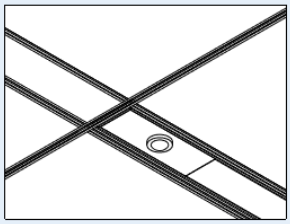
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

MVOLT

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/AMF	Anti-Microbial White (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits
WEC[6]	Entire run on EC

Control Input

(blank)	Non-dim[11]
ZT	0-10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

* Requires longer lead time.

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone, No Sensors
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone, No Sensors
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
SADC[13]	Daylight Dimming Sensor, No Sensors
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Act and/or Build America Buy America Qualified
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

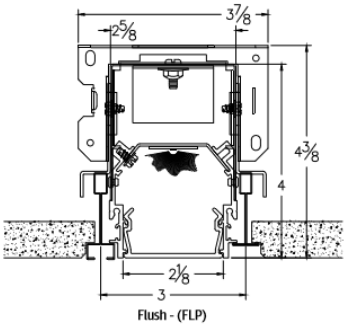
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

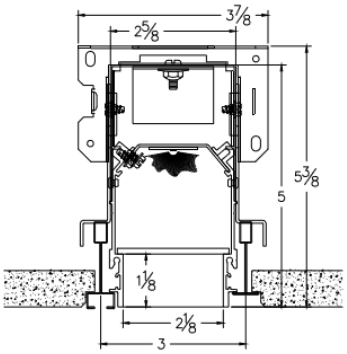
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

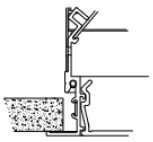


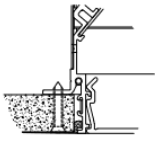
Flush - (FLP)

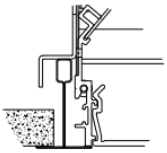


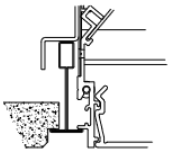
Regressed - (RLP)

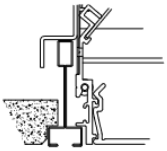
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

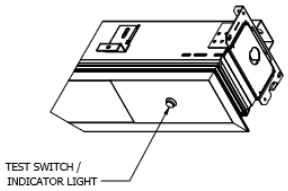

TG
(15/16" Grid)


TG
(9/16" Grid)

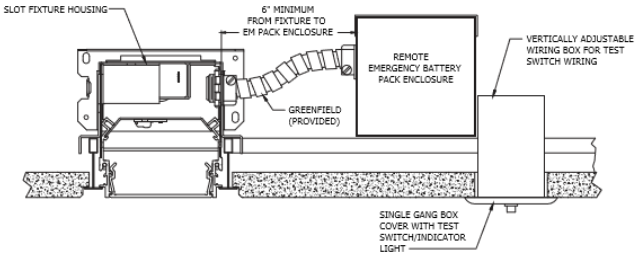

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

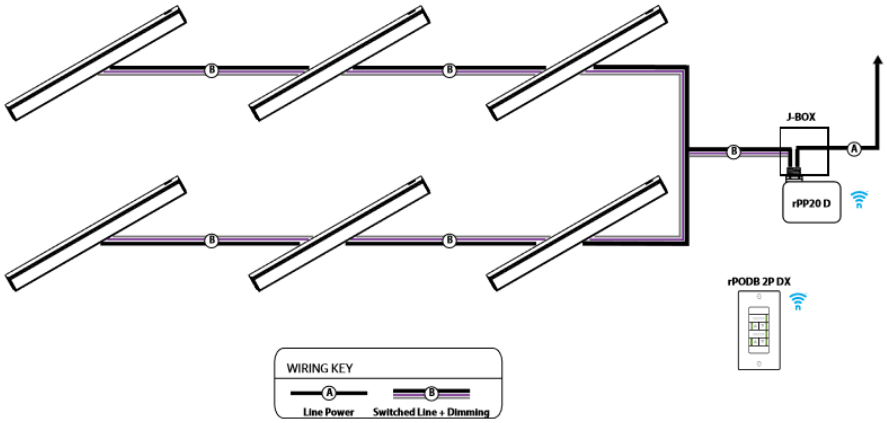
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

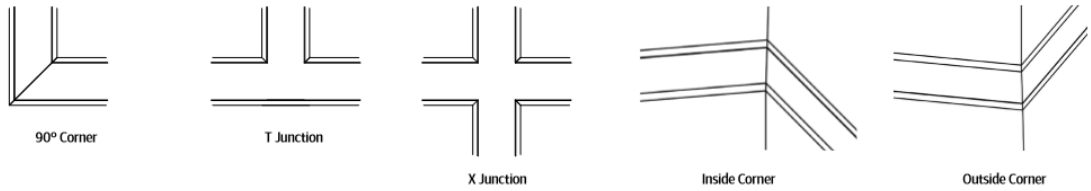


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

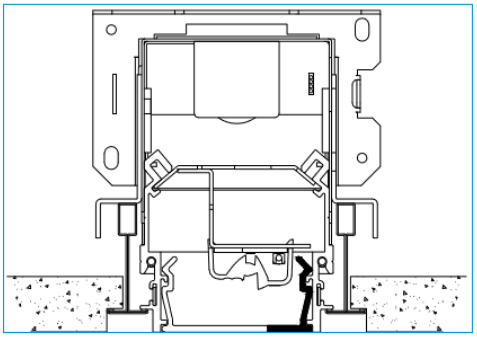
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

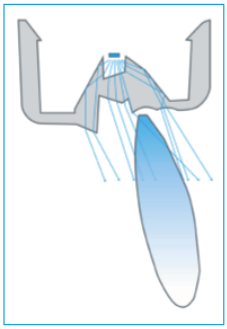
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

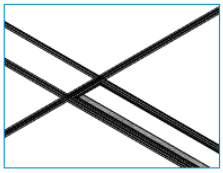
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

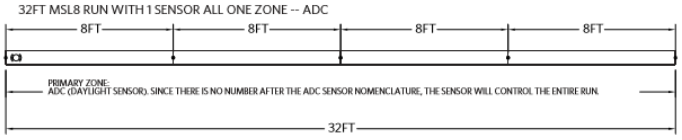




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

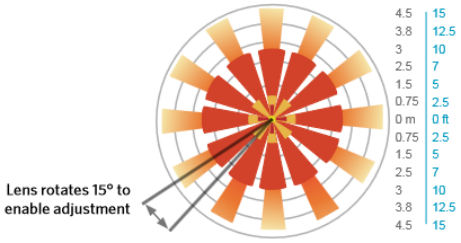
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-24FT01-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	142
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	23'-8" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

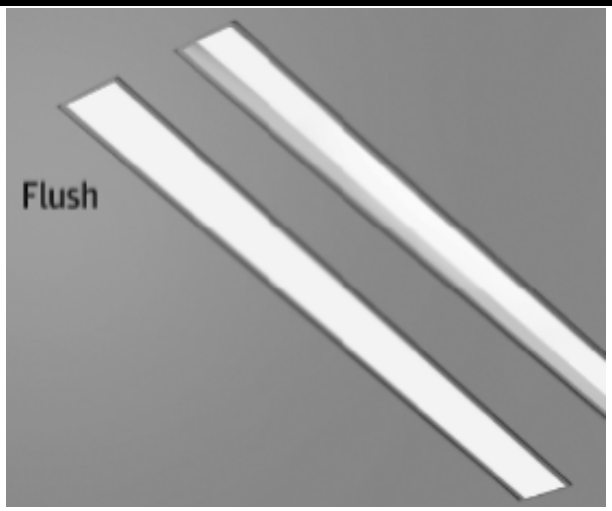
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

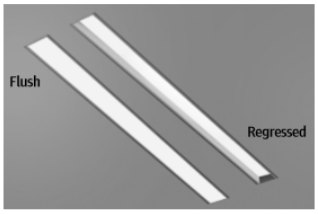
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2' x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1' increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

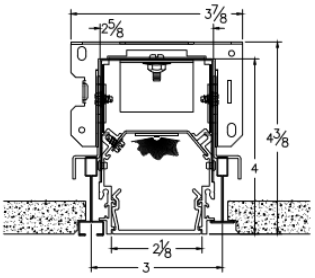
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



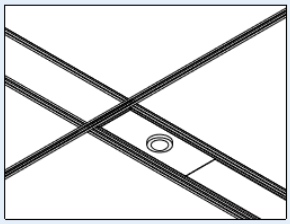
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

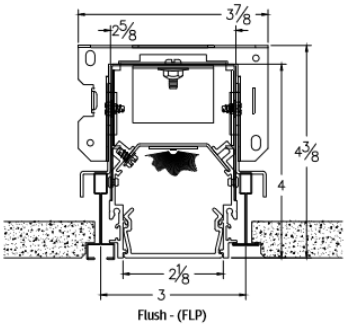
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

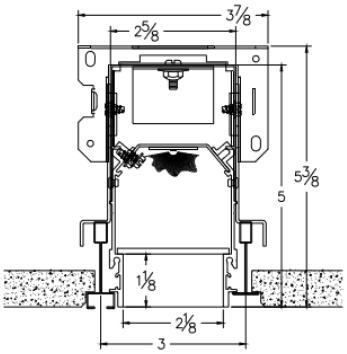
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

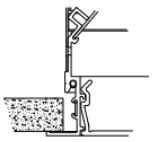


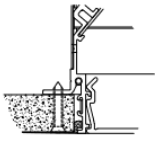
Flush - (FLP)

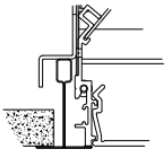


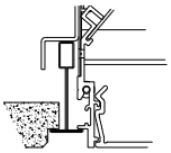
Regressed - (RLP)

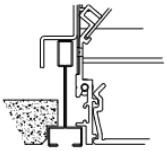
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

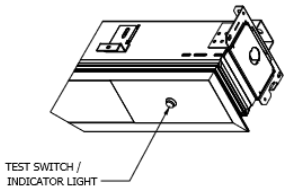

TG
(15/16" Grid)


TG
(9/16" Grid)

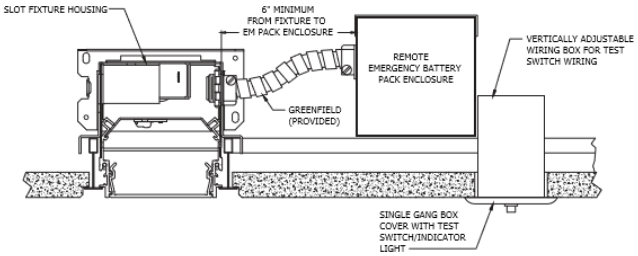

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

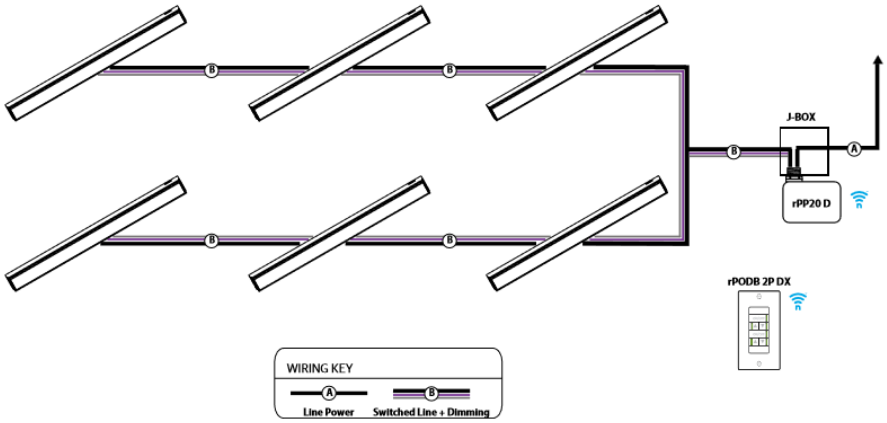
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

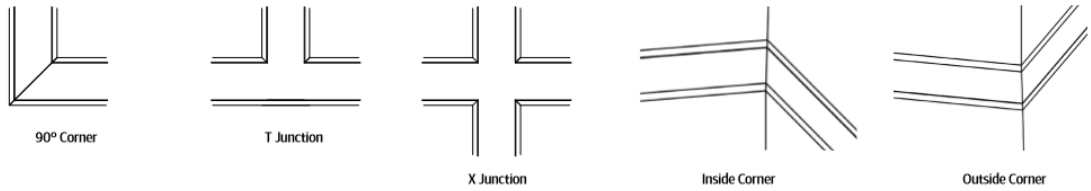


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



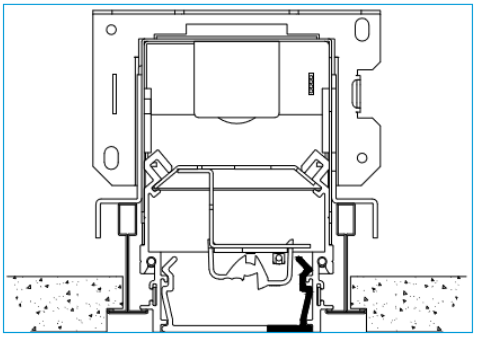
Layout Sketch

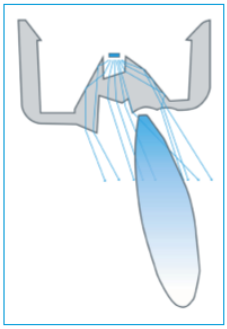
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

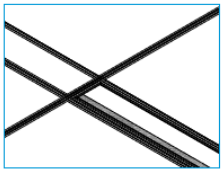
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

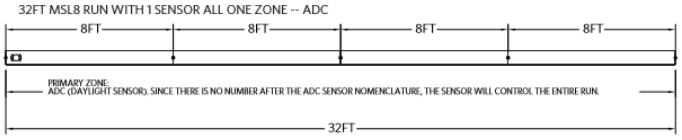




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

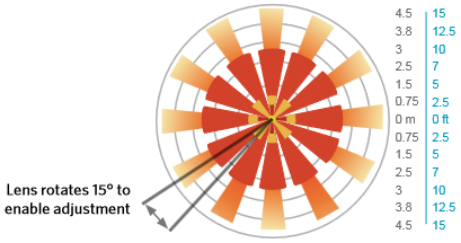
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-24FT03-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	47
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	7'-10" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

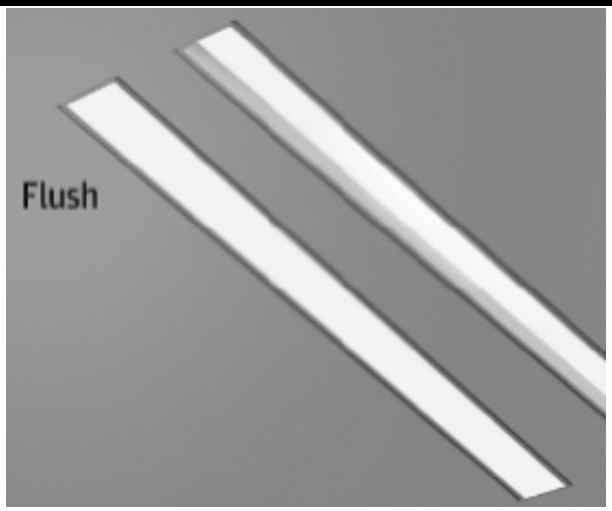
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000OK
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	65,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000OK color engine, 80 + CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option with a 65,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

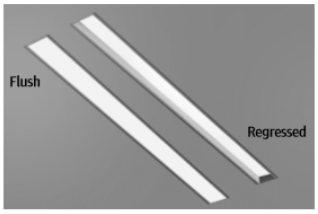
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

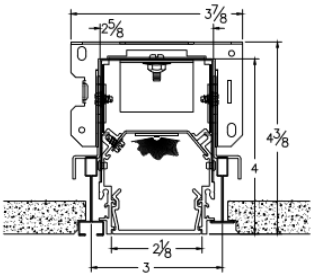
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



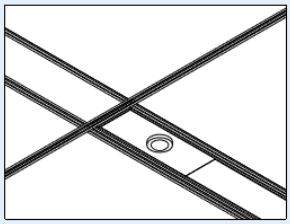
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

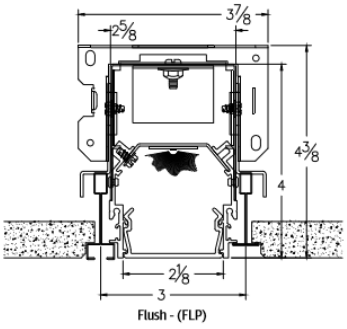
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

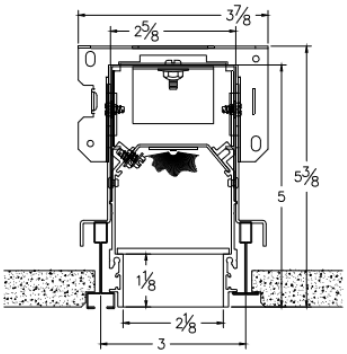
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

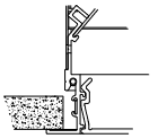


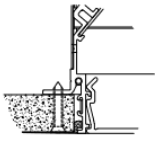
Flush - (FLP)

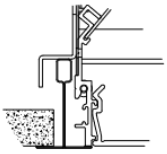


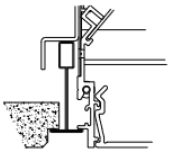
Regressed - (RLP)

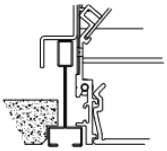
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

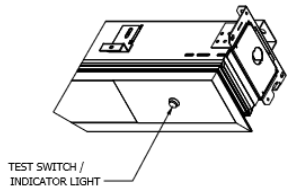

TG
(15/16" Grid)


TG
(9/16" Grid)

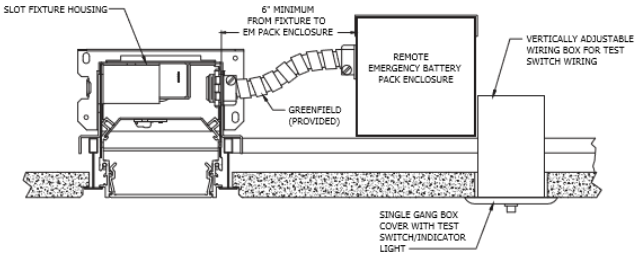

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

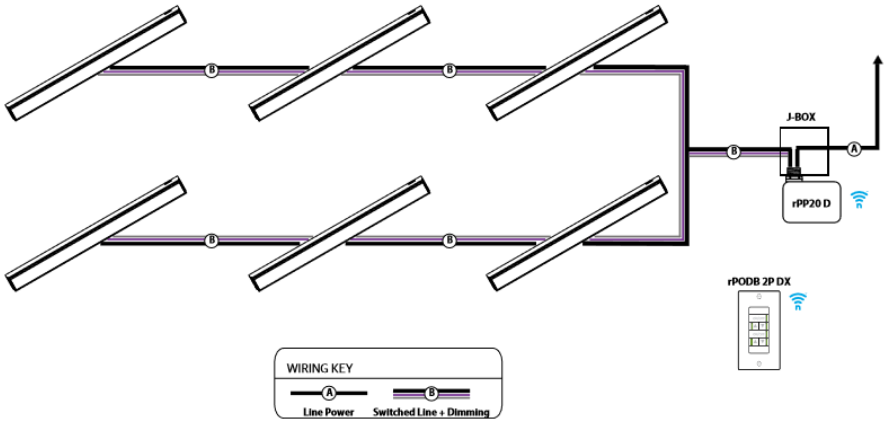
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

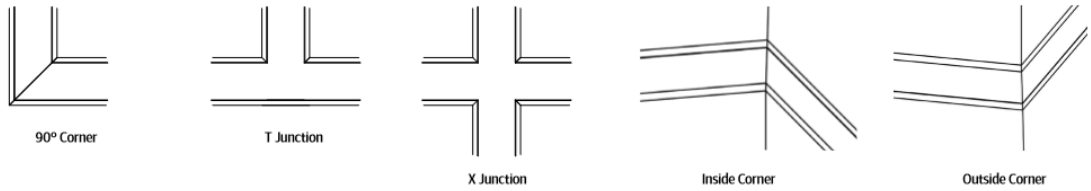


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

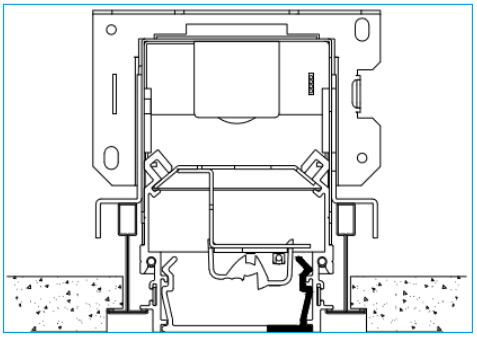
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

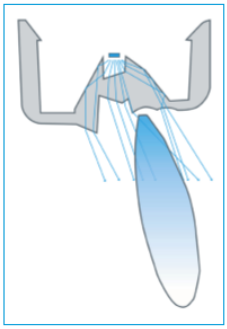
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

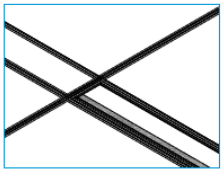
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

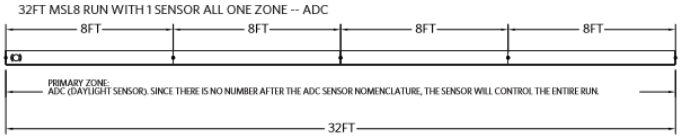




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

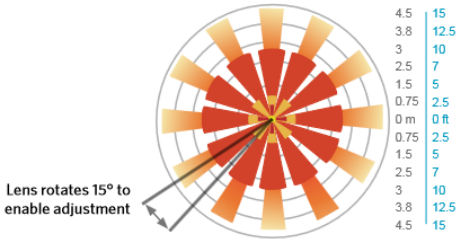
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-5FT00-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	26.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	4'-5" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

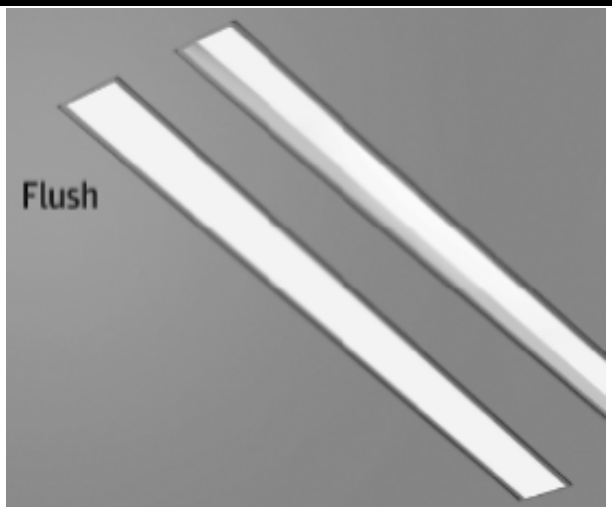
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	3000K
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 3000K delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

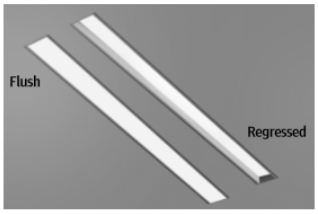
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

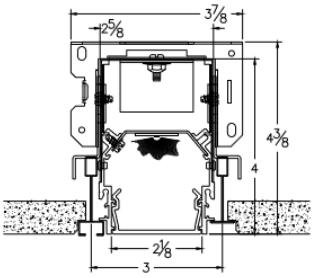
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



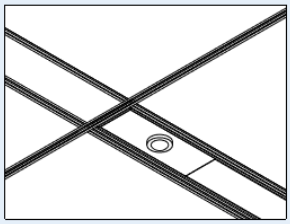
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series
- SL2L — Slot 2 LED Linear Recessed

Linear Length Plan
- LOP — Linear Optimized Plan

Total Run Length
- 2FT 2'
- 3FT 3'
- 4FT 4'
- 5FT 5'
- 6FT 6'
- 7FT 7'
- 8FT 8'
- _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
- _FT **Specify continuous linear feet in 1 foot increments

Fixture Style
- RLP[1,3] Regressed Lens
- FLP[2] Flush Lens

Ceiling Trim
- FL[4] 5/8" Flange(sheetrock)
- FLINB[21,22] 5/8" Flange (sheetrock) Install From Below
- TG 9/16" or 15/16" Flat or Inverted Tee
- GB[4] Trimless (sheetrock)
- WFL Perimeter Mount, 5/8" Flange (Sheetrock)
- WTG 9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering
- 80CRI 80 CRI
- 90CRI 90 CRI

MVOLT

Direct LED Color Temp
- 27K* 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K* 5000K

Direct LED Light Output
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution
- (blank) Standard Distribution
- WW[5] Wall Wash

Minimum Dimming Level
- NODIM Non - Dim
- MIN1 Constant current, dimming to 1%
- DARK Constant current, dimming to 0.1%
- MIN10[15] Constant current, dimming to 10%

Voltage
- 120 120V
- 277 277V
- 347[7] 347V

Finish
- (blank) White (satin)
- xxx/BLKT Black (satin)
- xxx/SLVT Silver (satin)
- xxx/AMF Anti-Microbial White (satin)
- xxx/RALTBD RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options
- (blank) No Emergency
- _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack
- _EC[10] # of Emergency Circuits
- WEC[6] Entire run on EC

Control Input
- (blank) Non-dim[11]
- ZT 0 10V
- NLIGHT nLight enabled
- NLTAIR2[17] nLight Air (Wireless Enabled)
- ECOD[8,16] Lutron Hi-Lume digital driver
- DALI[19] Dali

* Requires longer lead time.

Primary Sensor[12]
- (blank) Single Zone, No Sensor
- NS Multi-zone, No Sensor Main Zone, No Sensors
- PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
- ADC[13] Daylight Dimming Sensor
- API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
- APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]
- (blank) No additional zones/sensors
- SNS Multi-zone, with no sensor in secondary zone, No Sensors
- SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
- SADC[13] Daylight Dimming Sensor, No Sensors
- SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
- SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone
- (blank) No additional zones/sensors
- TNS Multi-zone, with no sensor in tertiary zone

Options
- CP[18] Chicago Plenum
- BAA Buy America(n) Act and/or Build America Buy America Qualified
- WL[3,9,20] Wet Location Listing
- DPL[20] Damp Location Listing
- PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes
1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

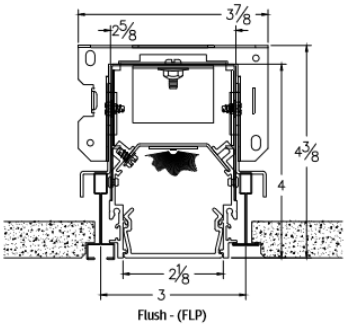
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

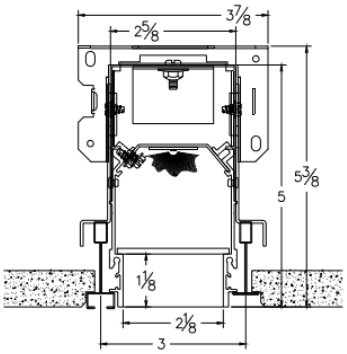
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

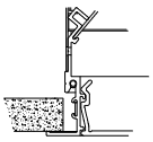


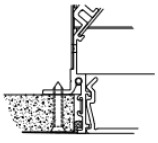
Flush - (FLP)

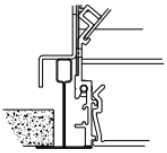


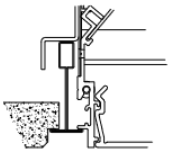
Regressed - (RLP)

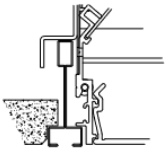
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

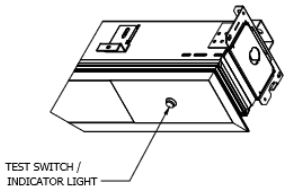

TG
(15/16" Grid)


TG
(9/16" Grid)

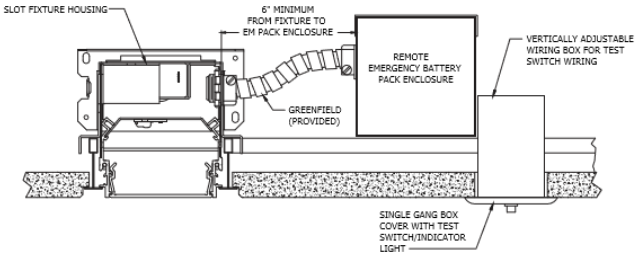

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

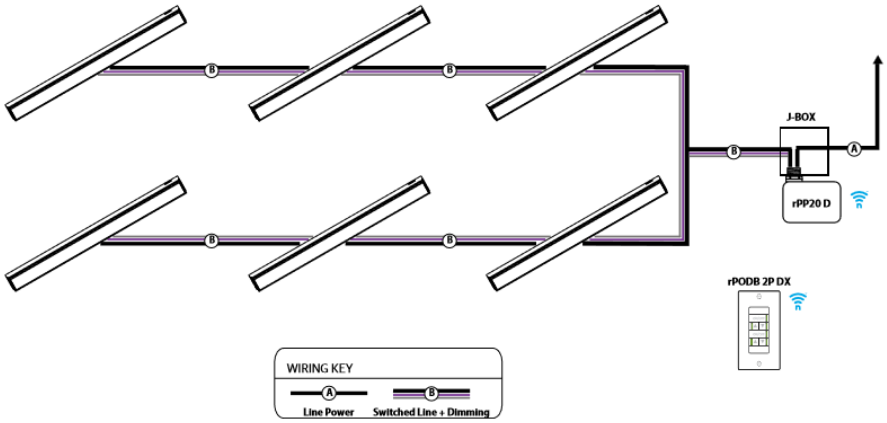
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

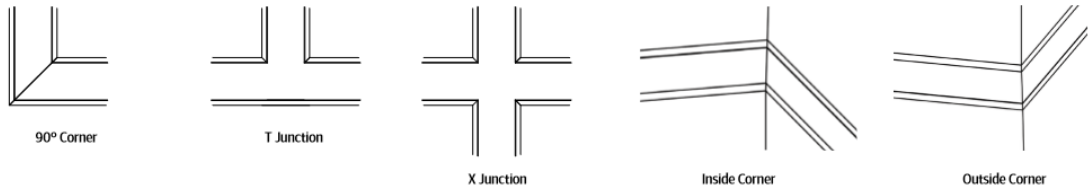


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

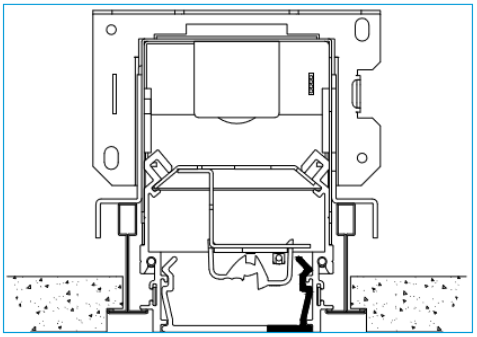
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

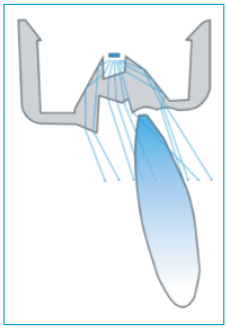
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

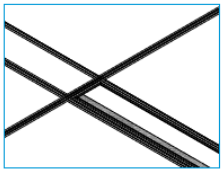
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

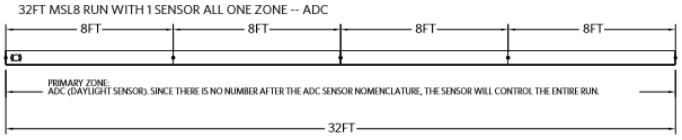




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

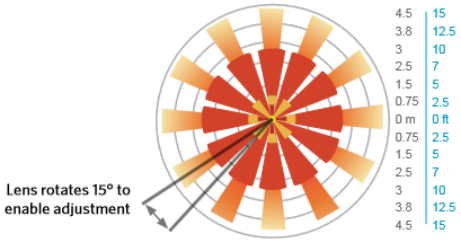
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-5FT10-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	125
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	20'-10" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

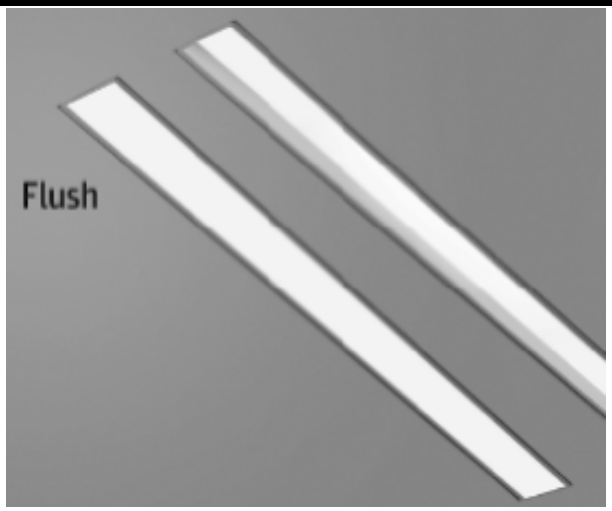
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

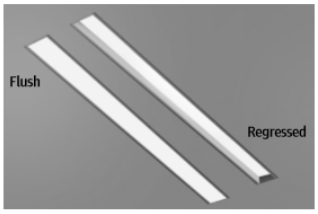
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

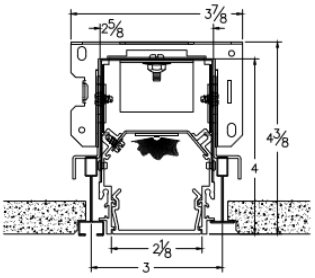
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



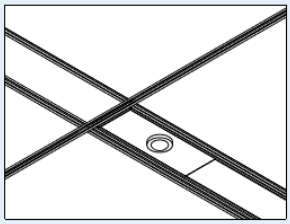
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**

Series
- SL2L — Slot 2 LED Linear Recessed

Linear Length Plan
- LOP — Linear Optimized Plan

Total Run Length
- 2FT 2'
- 3FT 3'
- 4FT 4'
- 5FT 5'
- 6FT 6'
- 7FT 7'
- 8FT 8'
- _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
- _FT **Specify continuous linear feet in 1 foot increments

Fixture Style
- RLP[1,3] Regressed Lens
- FLP[2] Flush Lens

Ceiling Trim
- FL[4] 5/8" Flange(sheetrock)
- FLINB[21,22] 5/8" Flange (sheetrock) Install From Below
- TG 9/16" or 15/16" Flat or Inverted Tee
- GB[4] Trimless (sheetrock)
- WFL Perimeter Mount, 5/8" Flange (Sheetrock)
- WTG 9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering
- 80CRI 80 CRI
- 90CRI 90 CRI

		MVOLT			
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**

Direct LED Color Temp
- 27K* 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K* 5000K

Direct LED Light Output
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- _LMF* [9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution
- (blank) Standard Distribution
- WW [5] Wall Wash

Minimum Dimming Level
- NODIM Non - Dim
- MIN1 Constant current, dimming to 1%
- DARK Constant current, dimming to 0.1%
- MIN10 [15] Constant current, dimming to 10%

Voltage
- 120 120V
- 277 277V
- 347 [7] 347V

Finish
- (blank) White (satin)
- xxx/BLKT Black (satin)
- xxx/SLVT Silver (satin)
- xxx/AMF Anti-Microbial White (satin)
- xxx/RALTBD RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options
- (blank) No Emergency
- _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack
- _EC[10] # of Emergency Circuits
- WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**

Control Input
- (blank) Non-dim [11]
- ZT 0 10V
- NLIGHT nLight enabled
- NLTAIR2 [17] nLight Air (Wireless Enabled)
- ECOD [8, 16] Lutron Hi-Lume digital driver
- DALI [19] Dali

Primary Sensor[12]
- (blank) Single Zone, No Sensor
- NS Multi-zone, No Sensor Main Zone, No Sensors
- PDT [13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
- ADC [13] Daylight Dimming Sensor
- API [14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
- APD [14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]
- (blank) No additional zones/sensors
- SNS Multi-zone, with no sensor in secondary zone, No Sensors
- SPDT [13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
- SADC [13] Daylight Dimming Sensor, No Sensors
- SAPI [14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
- SAPD [14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone
- (blank) No additional zones/sensors
- TNS Multi-zone, with no sensor in tertiary zone

Options
- CP [18] Chicago Plenum
- BAA Buy America(n) Act and/or Build America Buy America Qualified
- WL [3,9,20] Wet Location Listing
- DPL [20] Damp Location Listing
- PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes
1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

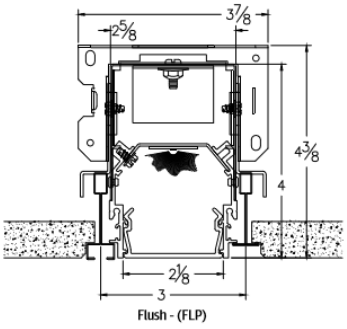
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

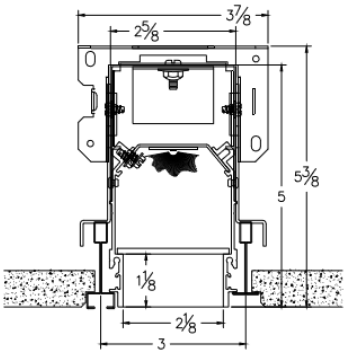
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

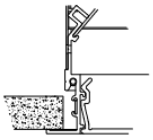


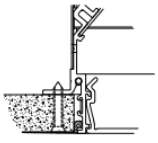
Flush - (FLP)

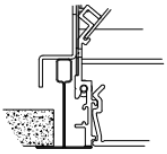


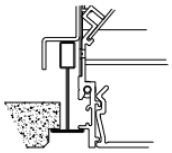
Regressed - (RLP)

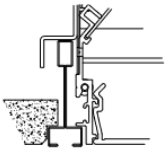
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

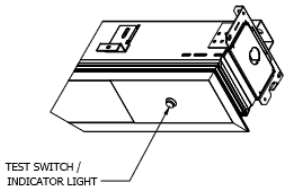

TG
(15/16" Grid)


TG
(9/16" Grid)

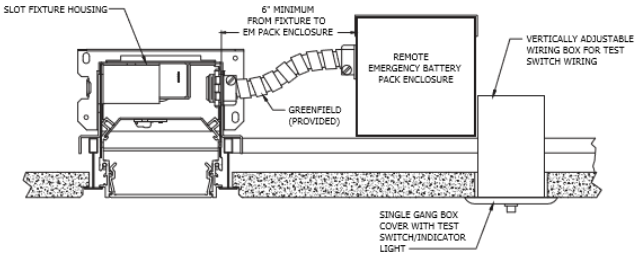

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

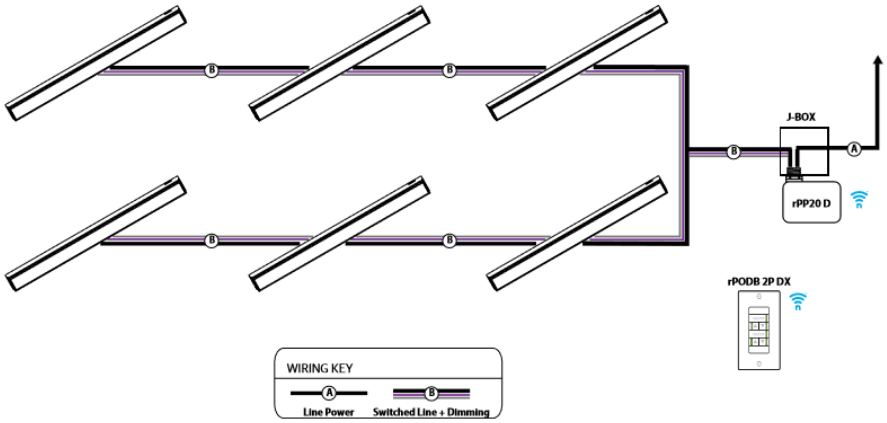
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

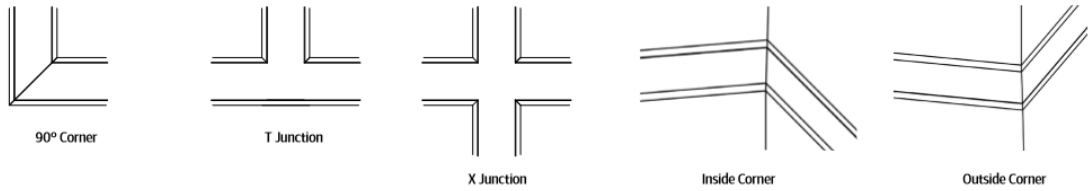


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

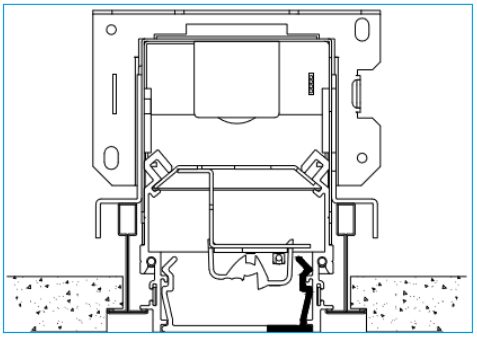
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

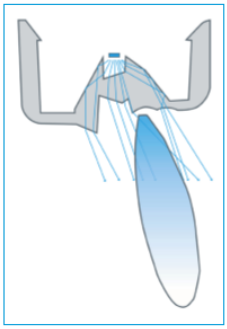
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

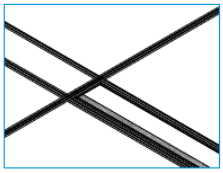
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

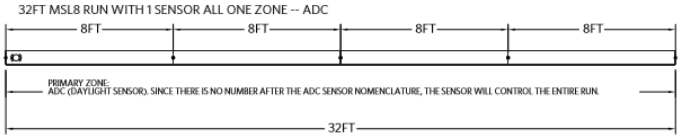




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

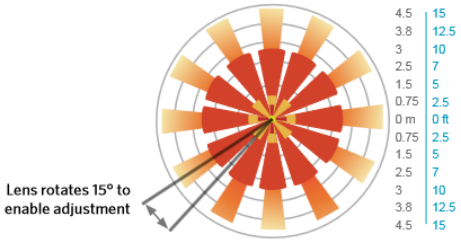
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-10FT10-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	23.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	3'-11" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

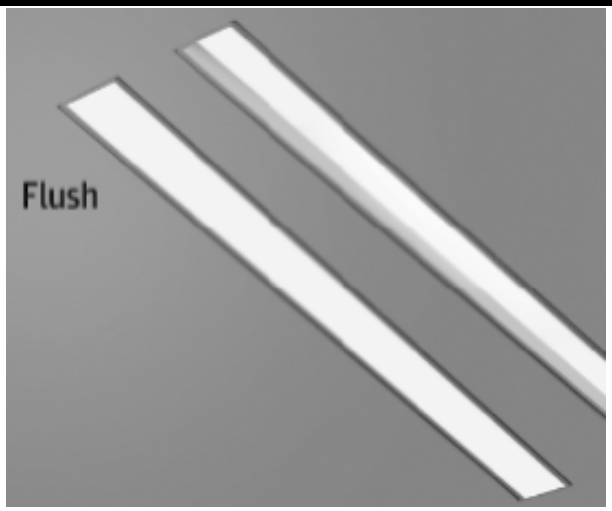
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 80+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

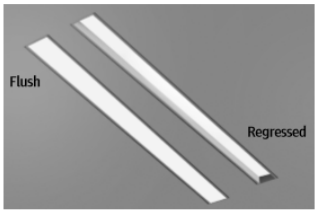
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:

DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

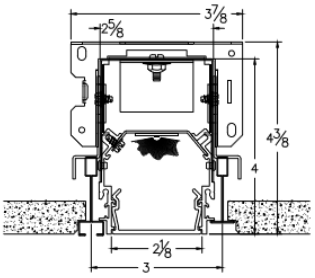
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



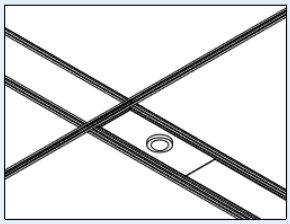
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**

Series
- SL2L — Slot 2 LED Linear Recessed

Linear Length Plan
- LOP — Linear Optimized Plan

Total Run Length
- 2FT 2'
- 3FT 3'
- 4FT 4'
- 5FT 5'
- 6FT 6'
- 7FT 7'
- 8FT 8'
- _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
- _FT **Specify continuous linear feet in 1 foot increments

Fixture Style
- RLP[1,3] Regressed Lens
- FLP[2] Flush Lens

Ceiling Trim
- FL[4] 5/8" Flange(sheetrock)
- FLINB[21,22] 5/8" Flange (sheetrock) Install From Below
- TG 9/16" or 15/16" Flat or Inverted Tee
- GB[4] Trimless (sheetrock)
- WFL Perimeter Mount, 5/8" Flange (Sheetrock)
- WTG 9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering
- 80CRI 80 CRI
- 90CRI 90 CRI

		MVOLT			
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**

Direct LED Color Temp
- 27K* 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K* 5000K

Direct LED Light Output
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution
- (blank) Standard Distribution
- WW[5] Wall Wash

Minimum Dimming Level
- NODIM Non - Dim
- MIN1 Constant current, dimming to 1%
- DARK Constant current, dimming to 0.1%
- MIN10[15] Constant current, dimming to 10%

Voltage
- 120 120V
- 277 277V
- 347[7] 347V

Finish
- (blank) White (satin)
- xxx/BLKT Black (satin)
- xxx/SLVT Silver (satin)
- xxx/AMF Anti-Microbial White (satin)
- xxx/RALTBD RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options
- (blank) No Emergency
- _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack
- _EC[10] # of Emergency Circuits
- WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**

Control Input
- (blank) Non-dim[11]
- ZT 0 10V
- NLIGHT nLight enabled
- NLTAIR2[17] nLight Air (Wireless Enabled)
- ECOD[8,16] Lutron Hi-Lume digital driver
- DALI[19] Dali

* Requires longer lead time.

Primary Sensor[12]
- (blank) Single Zone, No Sensor
- NS Multi-zone, No Sensor Main Zone, No Sensors
- PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
- ADC[13] Daylight Dimming Sensor
- API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
- APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]
- (blank) No additional zones/sensors
- SNS Multi-zone, with no sensor in secondary zone, No Sensors
- SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
- SADC[13] Daylight Dimming Sensor, No Sensors
- SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
- SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone
- (blank) No additional zones/sensors
- TNS Multi-zone, with no sensor in tertiary zone

Options
- CP[18] Chicago Plenum
- BAA Buy America(n) Act and/or Build America Buy America Qualified
- WL[3,9,20] Wet Location Listing
- DPL[20] Damp Location Listing
- PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes
1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

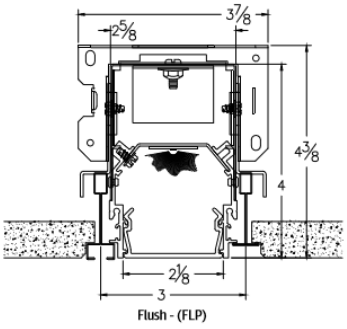
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

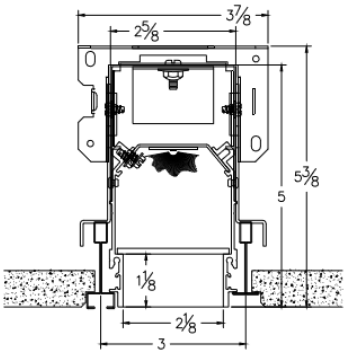
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

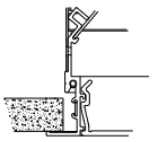


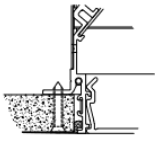
Flush - (FLP)

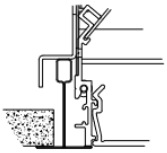


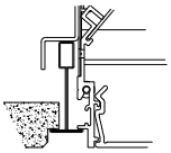
Regressed - (RLP)

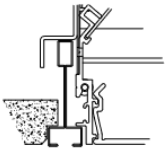
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

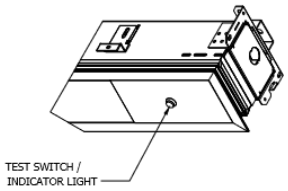

TG
(15/16" Grid)


TG
(9/16" Grid)

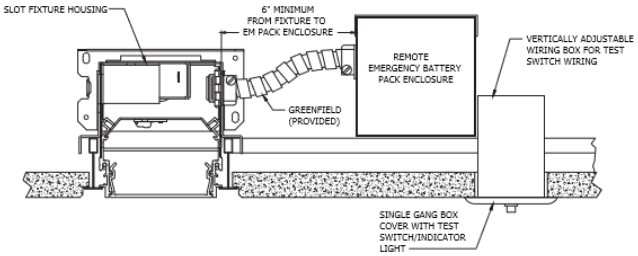

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

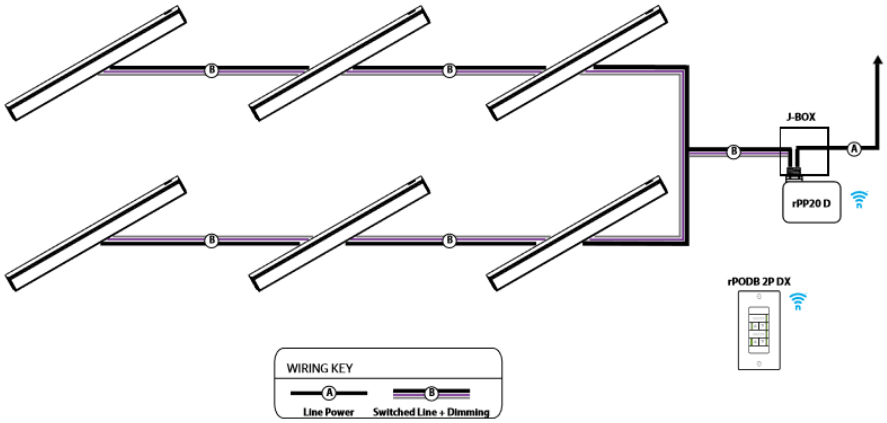
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

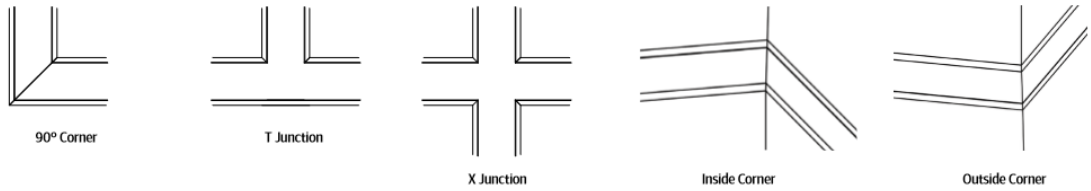


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

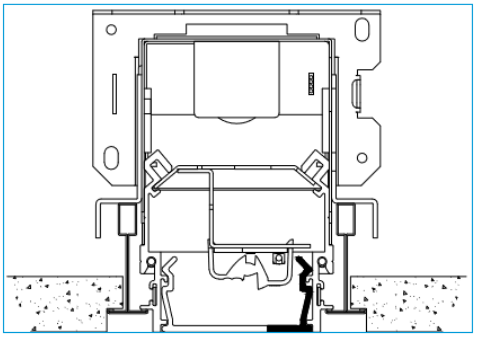
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

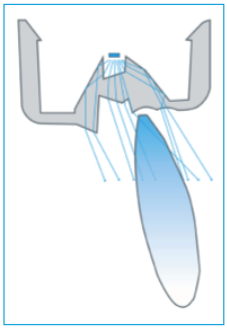
MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

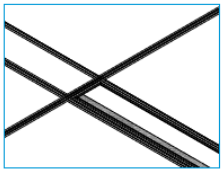
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

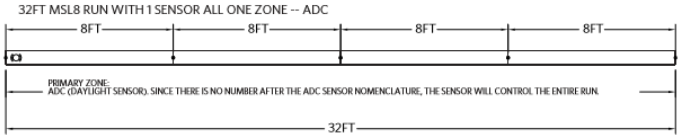




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

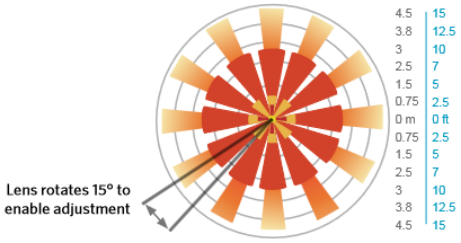
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	25.5
VOLTAGE	120-277
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	4'-3" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

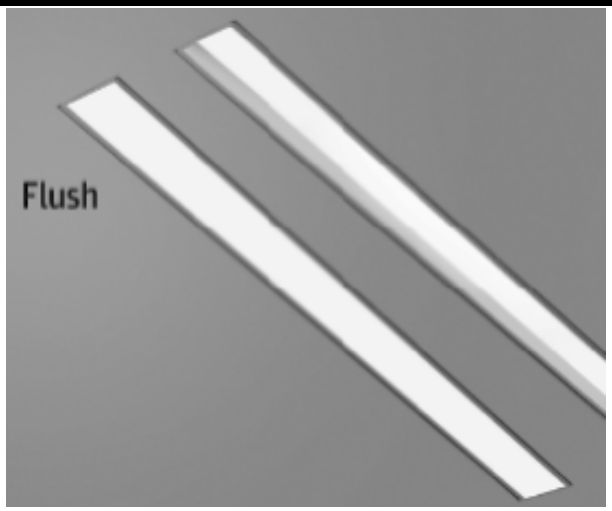
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	600W/FT
ANTICIPATED LIFE	65000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600W/FT delivered lumens, 3000K color engine, 90+ CRI, wall wash optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option with a 65000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

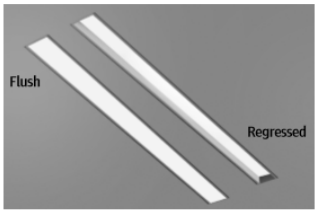
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:

DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

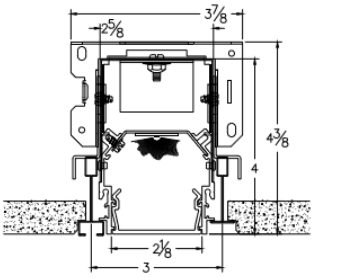
Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

Note: *UGR data available on Page 5*

Technical Drawing



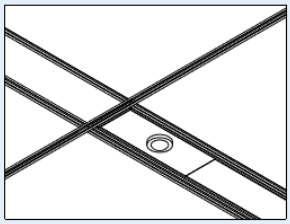
Flush - (FLP)

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

13FT09

Series

SL2L	Slot 2 LED Linear Recessed

Linear Length Plan

LOP	Linear Optimized Plan

Total Run Length

2FT	2'
3FT	3'
4FT	4'
5FT	5'
6FT	6'
7FT	7'
8FT	8'
_FT_	*Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)
_FT	**Specify continuous linear feet in 1 foot increments

Fixture Style

RLP[1,3]	Regressed Lens
FLP[2]	Flush Lens

Ceiling Trim

FL[4]	5/8" Flange(sheetrock)
FLINB[21,22]	5/8" Flange (sheetrock) Install From Below
TG	9/16" or 15/16" Flat or Inverted Tee
GB[4]	Trimless (sheetrock)
WFL	Perimeter Mount, 5/8" Flange (Sheetrock)
WTG	9/16" Flat or Inverted Tee, Perimeter Mount

*For metal pan, hard wood or other ceiling types consult factory.

Direct Light Source Color Rendering

80CRI	80 CRI
90CRI	90 CRI

MVOLT

Direct LED Color Temp

27K*	2700K
30K	3000K
35K	3500K
40K	4000K
50K*	5000K

Direct LED Light Output

400LMF	400 Lumens per FT
600LMF	600 Lumens per FT
800LMF	800 Lumens per FT
1000LMF	1000 Lumens per FT
_LMF*[9]	## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)

Direct Distribution

(blank)	Standard Distribution
WW[5]	Wall Wash

Minimum Dimming Level

NODIM	Non - Dim
MIN1	Constant current, dimming to 1%
DARK	Constant current, dimming to 0.1%
MIN10[15]	Constant current, dimming to 10%

Voltage

120	120V
277	277V
347[7]	347V

Finish

(blank)	White (satin)
xxx/BLKT	Black (satin)
xxx/SLVT	Silver (satin)
xxx/AMF	Anti-Microbial White (satin)
xxx/RALTBD	RAL paint finish

xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.

Emergency Options

(blank)	No Emergency
_E10WLCP[8]	Number of 4ft Emergency Section(s) with battery pack
_EC[10]	# of Emergency Circuits
WEC[6]	Entire run on EC

Control Input

(blank)	Non-dim[11]
ZT	0-10V
NLIGHT	nLight enabled
NLTAIR2[17]	nLight Air (Wireless Enabled)
ECOD[8,16]	Lutron Hi-Lume digital driver
DALI[19]	Dali

* Requires longer lead time.

Primary Sensor[12]

(blank)	Single Zone, No Sensor
NS	Multi-zone, No Sensor Main Zone, No Sensors
PDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor
ADC[13]	Daylight Dimming Sensor
API[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor
APD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Secondary Sensor[12]

(blank)	No additional zones/sensors
SNS	Multi-zone, with no sensor in secondary zone, No Sensors
SPDT[13]	Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors
SADC[13]	Daylight Dimming Sensor, No Sensors
SAPI[14]	Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors
SAPD[14]	Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors

Tertiary Zone

(blank)	No additional zones/sensors
TNS	Multi-zone, with no sensor in tertiary zone

Options

CP[18]	Chicago Plenum
BAA	Buy America(n) Act and/or Build America Buy America Qualified
WL[3,9,20]	Wet Location Listing
DPL[20]	Damp Location Listing
PWS	6' Pre-Wire, 3/8" Diameter, 18 Gauge

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

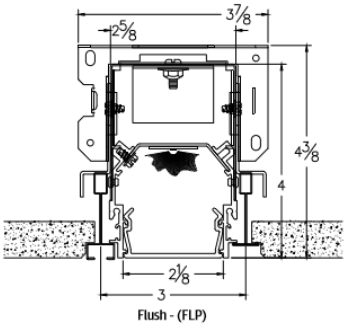
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

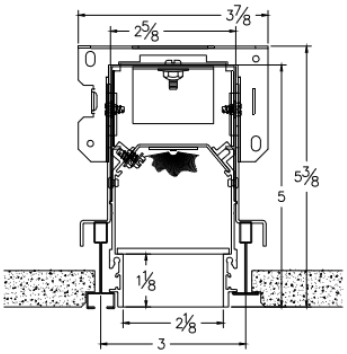
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

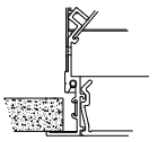


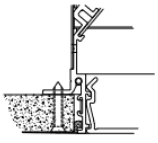
Flush - (FLP)

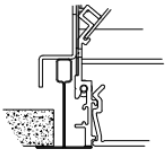


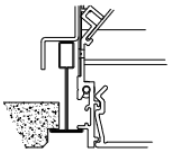
Regressed - (RLP)

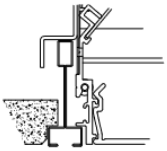
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

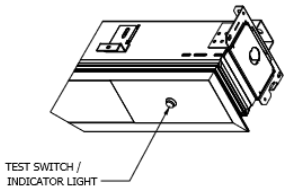

TG
(15/16" Grid)


TG
(9/16" Grid)

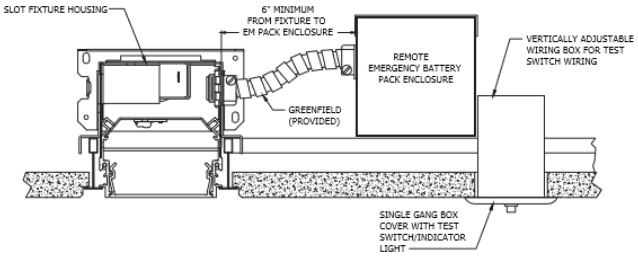

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



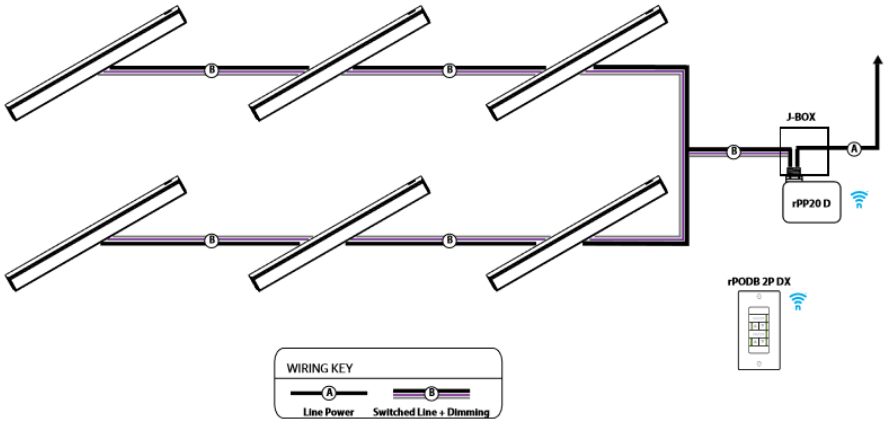
Notes
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

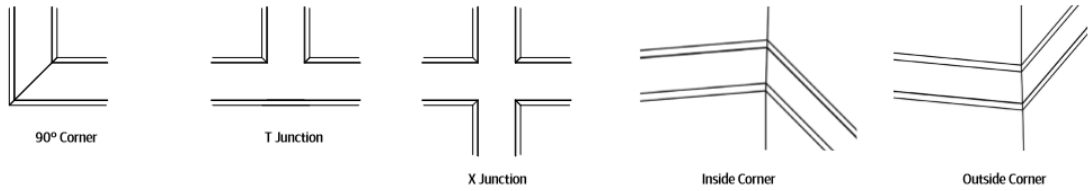


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



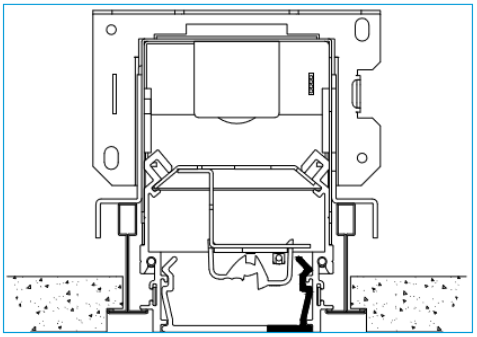
Layout Sketch

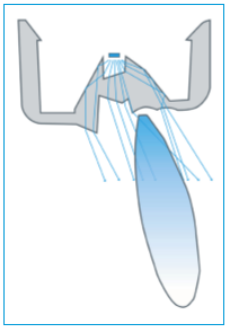
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

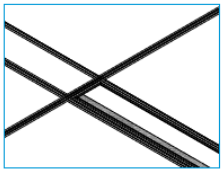
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

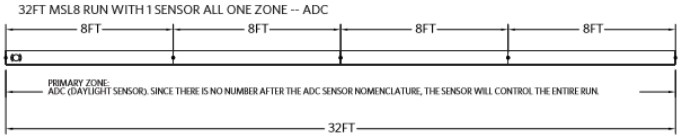




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

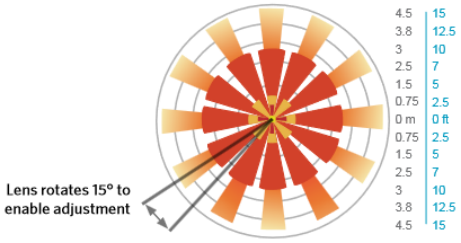
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-12FT03-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	296
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	49'-4" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

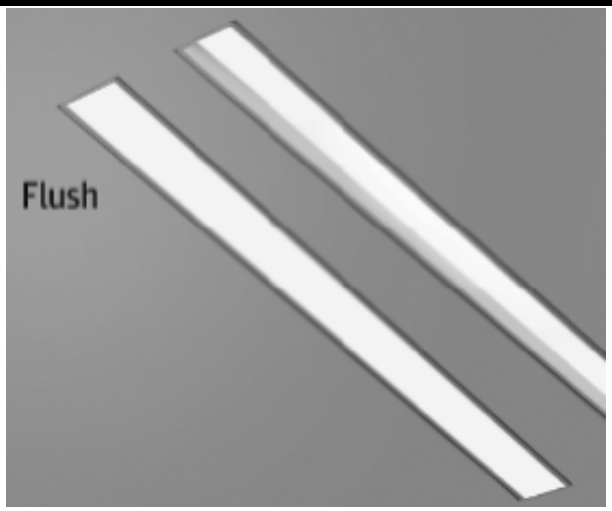
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	6000LM/FT
ANTICIPATED LIFE	65,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 6000LM/FT delivered lumens, 3000K color engine, 90 + CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 65,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

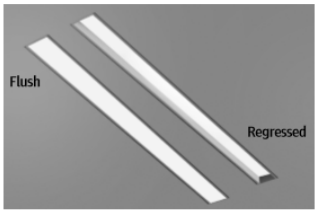
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:

DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

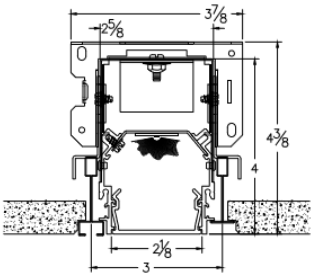
To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Technical Drawing



Flush - (FLP)

Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

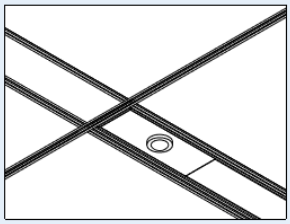
Note: *UGR data available on Page 5*

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect. *See ordering tree for details

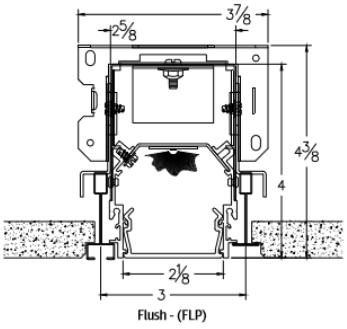
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

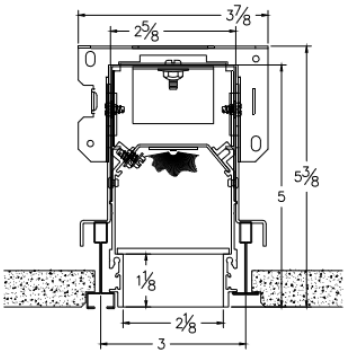
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

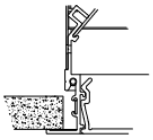


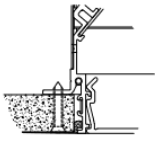
Flush - (FLP)

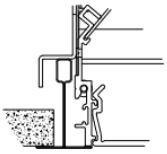


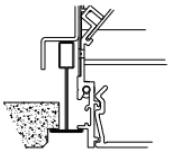
Regressed - (RLP)

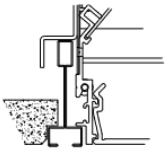
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

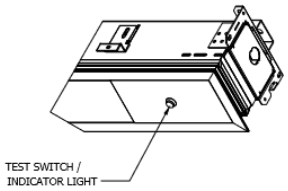

TG
(15/16" Grid)


TG
(9/16" Grid)

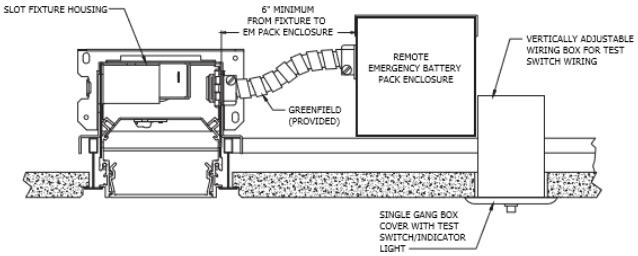

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

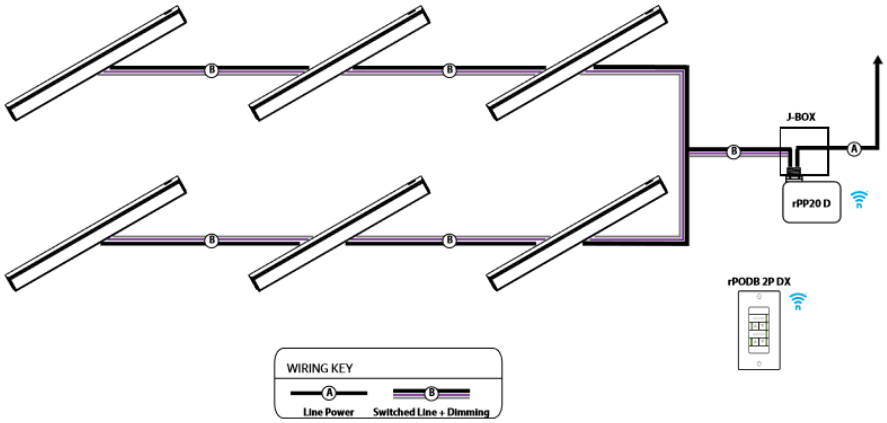
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

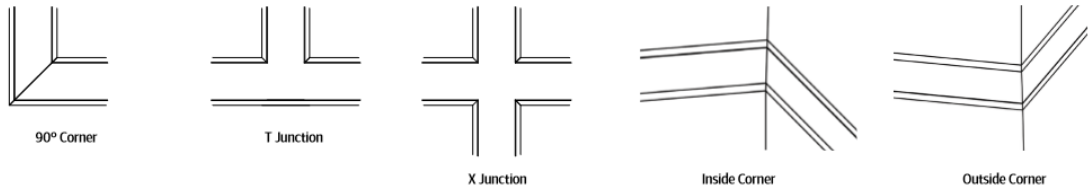


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

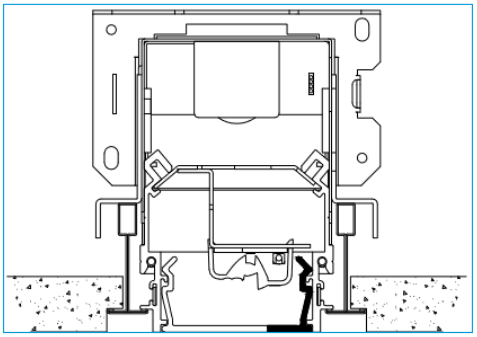
marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

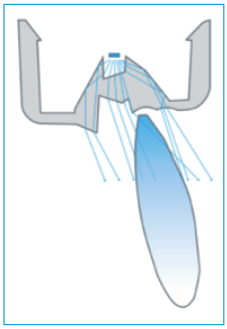
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

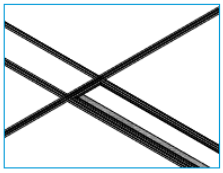
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

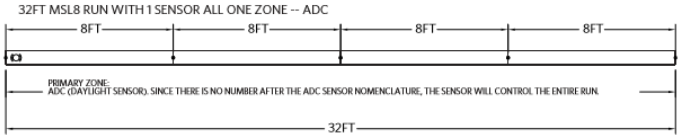




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

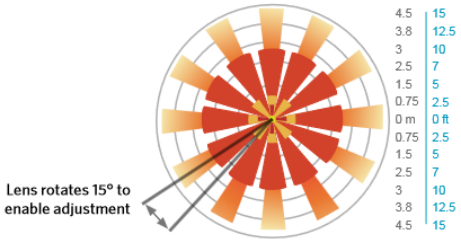
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	SL2L-LOP-12FT03-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT
TOTAL WATTS	157
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	26'-2" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

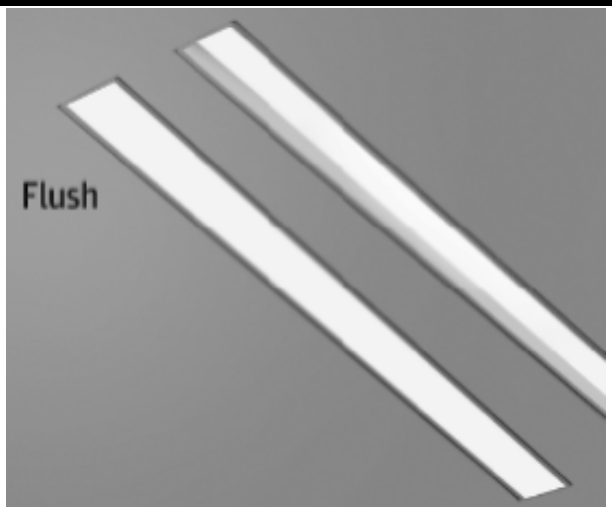
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	600LM/FT
ANTICIPATED LIFE	65,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 600LM/FT delivered lumens, 3000K color engine, 90+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 65,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

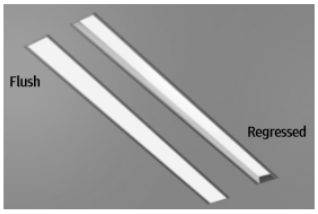
Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-W
W-DARK-MVOLT-ZT

Type:

MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear



Slot 2 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 2 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens. Lens is not sealed or gasketed.
Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750). This product is IC rated. Optional Damp (DPL) or Wet (WL) location listings available with specified nomenclature. Wet location listing is suitable for covered ceiling mount installation only, where any water exposure is beneath the non-porous mount surface.

Government Procurement
BAA - Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA - Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specification for chromatic consistency - including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

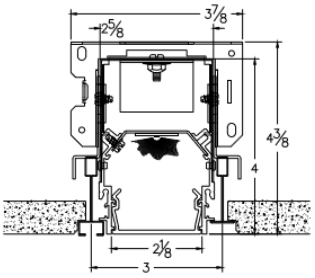
To learn more about Acuity A+ standards, specifications, and testing, visit www.acuitybrands.com/aplus

***Note:** Actual performance may differ as a result of end-user environment and application.*

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Technical Drawing



Flush - (FLP)

Fixture Performance - SL2L*

Lumens Output	400 LMF		600 LMF**		800LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	234	308	404	533	534	705	654	862
Input Watts/FT	4	4	6	6	8	8	11	11
Lumen/Watt	68	89	69	91	67	88	62	82

*CCT (35K)
*Consult factory for customized lumen output and wattage
**Based on calculated values

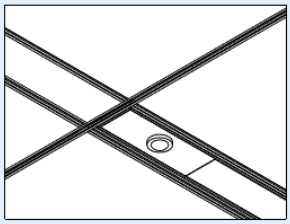
Note: *UGR data available on Page 5*

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

L51
SL2L-LOP-13FT09-FLP-90CRI-30K-600LMF-WW-DARK-MVOLT-ZT

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Recessed Linear

Design Select options indicated by this color background.

Ordering

Example: SL2L LOP 4FT FLP FL 80CRI 30K 600LMF DARK 277 EC NLIGHT

		13FT09			
Series	**Linear Length Plan**	**Total Run Length**	**Fixture Style**	**Ceiling Trim**	**Direct Light Source Color Rendering**
SL2L Slot 2 LED Linear Recessed	LOP Linear Optimized Plan	2FT 2' · 3FT 3' · 4FT 4' · 5FT 5' · 6FT 6' · 7FT 7' · 8FT 8' · _FT_ *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN) · _FT **Specify continuous linear feet in 1 foot increments	RLP[1,3] Regressed Lens · FLP[2] Flush Lens	FL[4] 5/8" Flange(sheetrock) · FLINB[21,22] 5/8" Flange (sheetrock) Install From Below · TG 9/16" or 15/16" Flat or Inverted Tee · GB[4] Trimless (sheetrock) · WFL Perimeter Mount, 5/8" Flange (Sheetrock) · WTG 9/16" Flat or Inverted Tee, Perimeter Mount · *For metal pan, hard wood or other ceiling types consult factory.	80CRI 80 CRI · 90CRI 90 CRI

MVOLT						
Direct LED Color Temp	**Direct LED Light Output**	**Direct Distribution**	**Minimum Dimming Level**	**Voltage**	**Finish**	**Emergency Options**
27K* 2700K · 30K 3000K · 35K 3500K · 40K 4000K · 50K* 5000K	400LMF 400 Lumens per FT · 600LMF 600 Lumens per FT · 800LMF 800 Lumens per FT · 1000LMF 1000 Lumens per FT · _LMF*[9] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	(blank) Standard Distribution · WW[5] Wall Wash	NODIM Non - Dim · MIN1 Constant current, dimming to 1% · DARK Constant current, dimming to 0.1% · MIN10[15] Constant current, dimming to 10%	120 120V · 277 277V · 347[7] 347V	(blank) White (satin) · xxx/BLKT Black (satin) · xxx/SLVT Silver (satin) · xxx/AMF Anti-Microbial White (satin) · xxx/RALTBD RAL paint finish · xxx = fill in with the appropriate ceiling trim. Only trims are painted. RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order.	(blank) No Emergency · _E10WLCP[8] Number of 4ft Emergency Section(s) with battery pack · _EC[10] # of Emergency Circuits · WEC[6] Entire run on EC

Control Input	**Primary Sensor[12]**	**Secondary Sensor[12]**	**Tertiary Zone**	**Options**
(blank) Non-dim[11] · ZT 0-10V · NLIGHT nLight enabled · NLTAIR2[17] nLight Air (Wireless Enabled) · ECOD[8,16] Lutron Hi-Lume digital driver · DALI[19] Dali	(blank) Single Zone, No Sensor · NS Multi-zone, No Sensor Main Zone, No Sensors · PDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor · ADC[13] Daylight Dimming Sensor · API[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor · APD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	(blank) No additional zones/sensors · SNS Multi-zone, with no sensor in secondary zone, No Sensors · SPDT[13] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor, No Sensors · SADC[13] Daylight Dimming Sensor, No Sensors · SAPI[14] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor, No Sensors · SAPD[14] Dual Technology Occupancy Sensor and Daylight Dimming Sensor, No Sensors	(blank) No additional zones/sensors · TNS Multi-zone, with no sensor in tertiary zone	CP[18] Chicago Plenum · BAA Buy America(n) Act and/or Build America Buy America Qualified · WL[3,9,20] Wet Location Listing · DPL[20] Damp Location Listing · PWS 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with regressed lens, sensor options or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall wash not available with RLP lens or all sensor options.
6. Not available with NLIGHT or NLTAIR2.
7. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
8. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP) If 5' or 6' unit, integral battery pack is only available with ZT or NLTAIR2. Battery will be remote with RLP, WW or sensors. Only 1 integral battery pack per unit. CP listing must have an intergral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
9. Not available with ECOD control input.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Only available with NODIM option.
12. Sensors not available with WW, NODIM driver, WL, RLP, or downlights. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
13. Requires ZT or NLIGHT Control Input.
14. Requires ZT, NLIGHT or NLTAIR2 Control Input. Only Design Select when ordered with NLTAIR2.
15. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
16. ECOD not available with sensors and requires MIN1 dimming.
17. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL.
18. CP not available with NLTAIR2.
19. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
20. Lens is not sealed or gasketed.
21. 1" increments will have extended lead time.
22. Not available with RLP regressed lens option.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

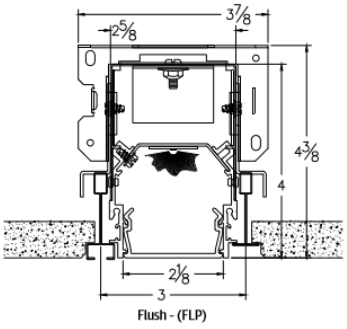
Maximum order quantity for Design Select lead times is 350 linear feet.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

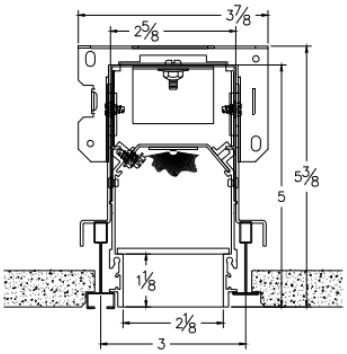
MARK
ARCHITECTURAL
LIGHTING™

Slot 2 LED
Recessed Linear

Technical Drawing

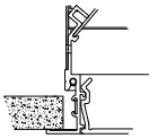


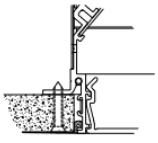
Flush - (FLP)

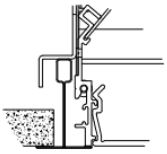


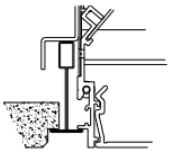
Regressed - (RLP)

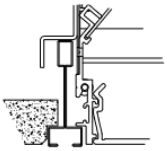
Ceiling Trim


FL
(Flanged sheetrock)


GB
(Flangeless sheetrock)

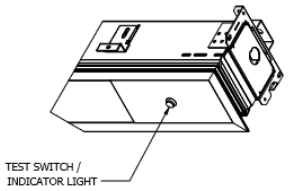

TG
(15/16" Grid)


TG
(9/16" Grid)

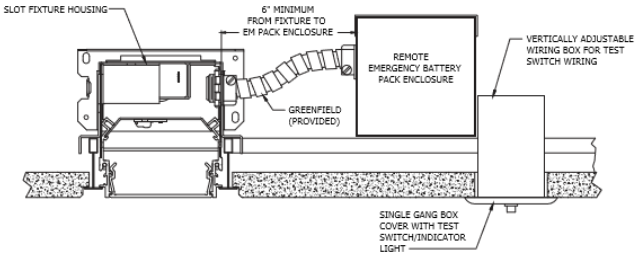

TG
(9/16" Slot Grid)

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes

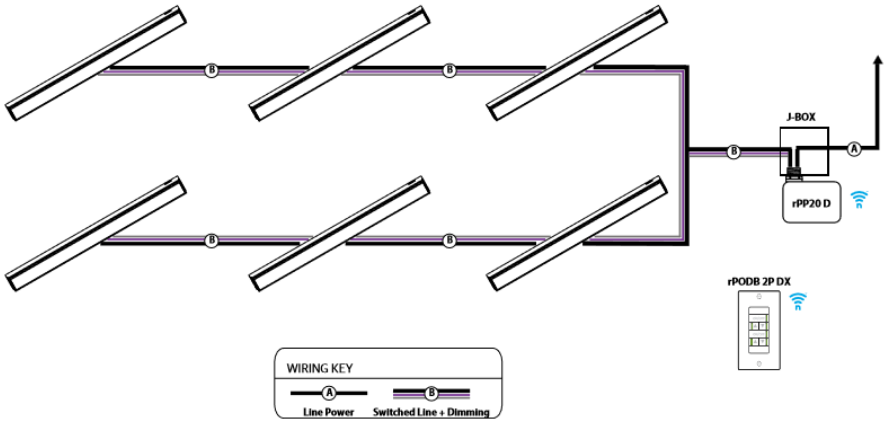
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

nLight Air Wireless

To Make fixture NLTAIR2 compatible the following components are required:

1) rpp20 D
2) rPODB 2P DX

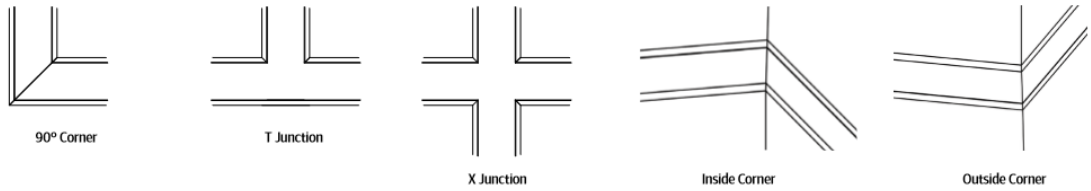


Continuous Runs

Slot 2 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



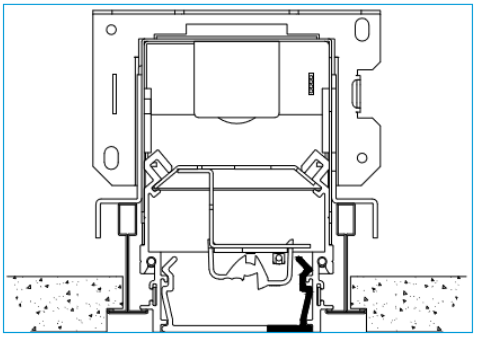
Layout Sketch

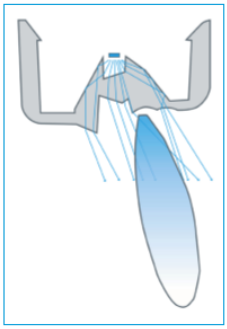
Please draw and configure your linear run below.

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

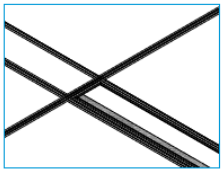
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

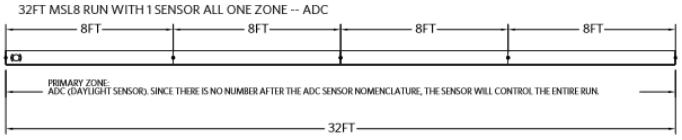




Optional Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

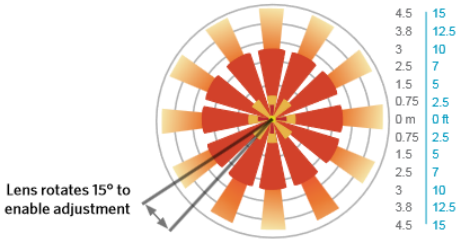
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.



UGR CHART

Lumen Package	UGR (70% 50% 20% REFLECTANCE USING A 4H X 8H ROOM SIZE)					
	Crosswise			Endwise		
	FLP	RLP	WW	FLP	RLP	WW
400LMF	22.1	22.2	19.6	20.8	18.2	20.3
600LMF	24	24.1	21.5	22.7	20.1	22.3
800LMF	25	25	22.4	23.7	21.1	23.2
1000LMF	25.7	25.7	23.1	24.4	21.8	23.9

**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.*
*** Click here for more information on UGR FAQ*

marklighting.com | 800-705-SERV (7378) | © 2015-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Mark Architectural Lighting
CATALOG NUMBER	S4PD-LCB-26FT2-MSL8-90CRI-30K-600LMF-WW-SCT-DARK-FLL-MVOLT-BLKT-ZT-F1A-72A-RDCY-BLKCY-BCRD
TOTAL WATTS	30
VOLTAGE	MVOLT
MOUNTING	Recessed
WEIGHT	1.75 lb/ft
DIMENSIONS	6'-3" x 3" x 3 3/8"
FINISH	White Powder Coat
RATING	IP
LISTING	UL

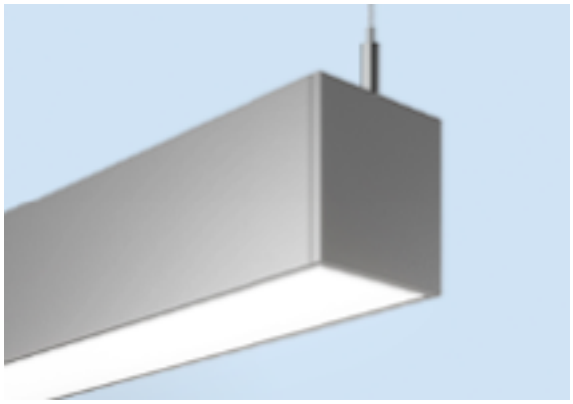
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	575/FT
ANTICIPATED LIFE	65,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Recessed mount wall wash linear with one (1) LED lighting source, 575/FT delivered lumens, 3000K color engine, 90+ CRI, wall wash optic and integral driver. Linear should operate on MVOLT voltage and be supplied with a 0-10v control option with a 65,000 hour anticipated life. Linear to have white powder coat finish. Linear should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

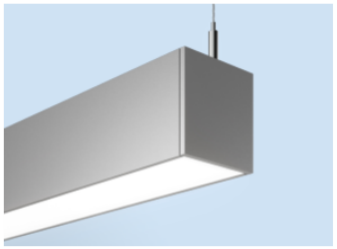
NOTES

Final Lengths to be confirmed onsite before fixture order is placed. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

MARK ARCHITECTURAL LIGHTING

SPECIFICATIONS

L61X
S4PD-LCB-XXFTXX-MSL8-90CRI-30K-600LMF-WW -SCT-DARK-FLL-MVOLT-BLKT-ZT-F1A-72A-RDCY -BLKCY-BCRD



SLOT 4

PENDANT DIRECT

HIGHLIGHTS

- 300 to 1500 lumens per foot Direct
- Up to 126 Lumens per Watt
- 5 direct distributions: Lambertian, Batwing, Wall Wash Wall Graze or Asymmetric
- Multiple lens treatment options include Continuous, Drop, in 1/2", 1"or 1 1/2" and Edge View
- Shielding provided by optional deep cell baffle
- Integrated control with optional nLight or nLight Air for system networking
- Driver options for Dim to Dark, 1% or 10% minimum dimming
- White, black or silver paint with satin finish
- Declare listed
- UGR data available on page 3

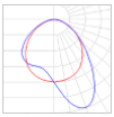
FIXTURE PERFORMANCE

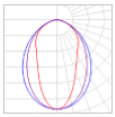
	Direct							
Nominal Lumens/Foot	300LMF	400LMF	600LMF	800LMF	1000LMF	1200LMF	1400LMF	1500LMF
Delivered Lumens/Foot	292	394	575	791	973	1192	1352	1442
Input Watts/Foot	2.39	3.14	4.68	6.33	7.96	10.00	11.93	13.01
Lumens/Watt	122	126	123	125	122	119	113	111

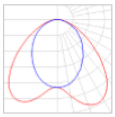
Based on 4FT, 80CRI, 35K with standard Lambertian distribution.

DIRECT DISTRIBUTION

Lambertian (No Optic)

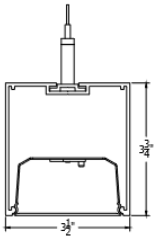

Wall Wash (WW)


Wall Graze (WG)


Batwing (DBW)

DIMENSIONS

See page 5 for additional details.



DIFFUSERS/SHIELDING

Flush Lens (FLL)

Regressed Louver (LVRR)

Edge View Lens (EGLD)

1/2" Drop Lens (DRP05)

1" Drop Lens (DRP1)

1-1/2" Drop Lens (DRP15)

© 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

Visual Terrain® www.visualterrain.net		PROJECT: Bentonville Ballroom CLIENT: Live Nation SUBMISSION: 100% Detail Design DOCUMENT #:	**EQUIPMENT TYPE** L61a
DATE: 10/23/2026	REVISION #		
PAGE 361 OF 505	0	Equipment Page 2 of 11	

MARK ARCHITECTURAL LIGHTING™

SLOT 4
Pendant Direct

Design Select options indicated by this color background.

ORDERING Example: S4PD LLP 32FT MSL8 90CRI 35K 800LMF MIN1 FLL SCT MVOLT WHTT ZT F1/36A RDCY WHTCY WCRD

Series
- S4PD Slot 4 Pendant Direct

Linear Plan
- LLP Linear longest possible
- LCB Linear center balanced
- LSL Longest same length

For more information on linear plans, see page 4.

Total Run Length
- _FT_ Specify continuous run length (in 1" increments, 2' minimum)
- _FT Specify continuous run length (in 1' increments, 2' minimum)

Unit length may affect available options. Please contact your Acuity representative for assistance.

For runs longer than 8FT ALWAYS order the run by the TOTAL RUN LENGTH. Ordering the sections individually will not provide the correct joining hardware to allow connection in the field.

Max Section Length
- MSL2 2'
- MSL3 3'
- MSL4 4'
- MSL5 5'
- MSL6 6'
- MSL7 7'
- MSL8 8'

Direct Light Source Color Rendering
- 80CRI 80CRI+
- 90CRI 90 CRI

Direct LED Color Temp
- 27K 2700K
- 30K 3000K
- 35K 3500K
- 40K 4000K
- 50K 5000K

Direct LED Light Output
- 300LMF 300 Lumens per FT
- 400LMF 400 Lumens per FT
- 600LMF 600 Lumens per FT
- 800LMF 800 Lumens per FT
- 1000LMF 1000 Lumens per FT
- 1200LMF 1200 Lumens per FT
- 1400LMF 1400 Lumens per FT
- 1500LMF 1500 Lumens per FT
- _LMF Specify Lumens between 300LMF - 1500LMF in 50LMF increments.

Lumen output may affect available options. Please contact your Acuity representative for assistance.

Direct Distribution
- (blank) Standard Distribution
- WW Wallwash Distribution
- WG Wall Graze Distribution
- DBW Direct Batwing Distribution

Direct Distribution options are only available with FLL.

Switching
- SCT Single Circuit/Single switching

Minimum Dimming Level
- NODIM[1] No Dimming
- MIN1 Constant current dimming to 1%
- MIN10 Constant Current, Dimming to 10%
- DARK Constant current dimming to 0.1%

1. NODIM is not available with Control Input.

Direct Shielding
- FLL Flush lens
- LVRR[1,2] Regressed Louver
- LVRRA[1] Natural Aluminum Regressed Louver
- EGLD[1] Edge Glow Direct Lens (edgeview)
- DRPO5[1] 1/2 drop
- DRP1[1] 1 drop
- DRP15[1] 1.5" drop lens
- CLL[3] Continuous Flush Lens

1. Only available in whole feet. Not available with sensors.
2. Louver is painted to match fixture color.
3. CLL is not available with sensors.

Voltage
- MVOLT Multi-volt, 120-277
- 120 120V
- 277 277V
- 347[1] 347V

1. 347 is only available with ZT. 347 is not available with DARK, EC, E10WLCP, GTD or sensors.

Finish
- WHTT White, Satin
- BLKT Black, Satin
- SLVT Silver, Satin
- RALTBD RAL paint finish

RALTBD is for pricing only. Replace with applicable RAL number & finish when placing order. Click here for more information on our paint finishes.

Emergency Options
- (blank) No Emergency Options
- _E10WLCP[1] # of 10W Battery Packs, Constant Power, Self Diagnostics, T20 Compliant
- WEC[2] Emergency circuit for entire run
- _EC # of Emergency Circuits
- GTD[3] Generator Transfer Device (remote)

1. E10WLCP is not available with 2' sections or TGLD.
2. WEC is not available with NLIGHT, NLTAIR2, sensors or individual units.
3. GTD is remote mounted. (See more information on page 9.) GTD is not available with MVOLT.

Control Input
- (blank) No Dim
- ZT 0-10V
- NLIGHT[1] nLight Wired
- NLTAIR2[2] nLight Air 2 Wireless Enabled
- DALI[3] DALI
- ECOD[4] Lutron EcoSystem Digital Driver

1. NLIGHT comes with a white CAT5 cord in addition to the standard power cord. Will require remote mounted nIO, purchased separately, on fixtures less than 3'. One NLIGHT device per zone or sensor.
2. NLTAIR2 is not available with a 2' section & DCT.
3. DALI is only available with DARK.
4. ECOD is only available with MIN1. It is not available with MVOLT, E10WLCP or GTD. It is only available with 300LMF, 600LMF, 1000LMF or 1500LMF.

Primary Sensor
- (blank) No Sensor/Zones
- NS_ Primary zone with no Sensor (Specify length in feet)
- ADC[1] Daylight Dimming Sensor
- PDT[1] Dual Technology Occupancy, PIR and Microphonics Sensor
- APDT Dual technology Occupancy and Daylight Dimming Sensor
- APIR Passive Infrared Occupancy and Daylight Dimming Sensor

Sensors are only available with FLL lens. Sensors are not available with DCT, 347, NODIM, WEC, DALI & ECOD.
1. PDT or ADC are not available with NLTAIR2.
Design Select sensors only available with NLTAIR2.

Secondary Zone
- (blank) No Sensor/Zones
- SNS_ No Sensor, Secondary Zone (Specify length in feet)
- SADC[1] Daylight Dimming Sensor
- SPDT[1] Dual Technology Occupancy, PIR and Microphonics Sensor
- SAPDT Dual technology Occupancy and Daylight Dimming Sensor
- SAPIR Passive Infrared Occupancy and Daylight Dimming Sensor

Sensors are only available with FLL lens. Sensors are not available with DCT, 347, NODIM, WEC, DALI & ECOD.
1. SPDT or SADC are not available with NLTAIR2.
Design Select sensors only available with NLTAIR2.

Tertiary Zone
- (blank) No Tertiary Zone
- TNS_ No Sensor, Tertiary Zone (Specify length in feet)

Mounting
- F1/[1] T-Bar Ceiling (universal mounting bracket)
- F1A/[1] T-Bar Ceiling (UMB with integrated J-BOX)
- F2/ Hard ceiling (horizontal J-box)

1. Please reference page 6 for ceiling type details.

Overall Suspension
- 36A 36" Adjustable
- 72A 72" Adjustable
- 144A 144" Adjustable
- 240A 240" Adjustable
- 300A[1] 300" Adjustable

1. Black cord is not available with 300A.

Canopy Form
- RDCY Round Canopy
- SQCY Square Canopy

Canopy Color
- WHTCY White Canopy
- SLVCY Silver Canopy
- BLKCY Black Canopy

Cord Color
- WCRD White cord
- BCRD Black cord
- CCRD Clear cord

CAT5 cord, when included will be white.

Options
- (blank) No Options
- PIF[1] Feed Cord Installed
- MCS Matching Canopy
- BAA Buy America(n) Act and/or Build America Buy America Qualified

1. Cord length will match overall suspension length specified.

NOTE: *Unit length and lumen outputs may affect available options. Please contact your Acuity representative for assistance.*

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

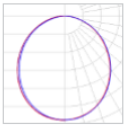
Maximum order quantity for Design Select lead times is 350 linear feet.

 © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

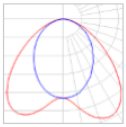
MARK ARCHITECTURAL LIGHTING™

SLOT 4 Pendant Direct

PHOTOMETRICS



Test Report: ISF 22230OP181
IES LM79-08
S4PD U4 80CRI 35K 1000LMF
Lumens: 3889.8
Wattage: 31.85
Efficacy: 122.13



Test Report: ISF 23344P181
IES LM79-08
S4PD U4 80CRI 35K 1000LMF DBW
Lumens: 3103.9
Wattage: 31.85
Efficacy: 97.45

EXPECTED LIFE: L90 @ 60,000 HOURS
CALCULATED LIFE: L80 @ 120,000 HOURS

CCT SCALING CHART

CCT	CRI	MULTIPLIER
27K	80CRI	0.94
30K	80CRI	0.97
35K	80CRI	1.00
40K	80CRI	1.02
50K	80CRI	1.04
27K	90CRI	0.79
30K	90CRI	0.81
35K	90CRI	0.83
40K	90CRI	0.84
50K	90CRI	0.88

Lumen scaling charts can be used to approximate the lumen values at different Kelvin temperatures, color rendering indices, optics or sheilding.
Example: Find base lumen value x multiplier value = new lumen value

OPTICAL SCALING CHARTS

DOWNLIGHT	
DISTRIBUTIONS	MULTIPLIER
WW	0.80
WG	0.85
DBW	0.80

**Base fixture with Lambertian distribution and flush lens*

UGR CHART

Lumen Package	UGR (70% 50% 20% reflectance using a 4H x 8H room size)										
	Crosswise										
	Lambertian	CLL	WW	WG	DBW	LVRR	LVRRA	EGLD	DPR05	DRP1	DRP15
300LMF	20.2	20.5	13.5	19.1	17.2	8.3	8.2	20.2	19.2	17.5	16.4
400LMF	21.3	21.6	14.5	20.2	18.3	9.4	9.3	21.2	20.2	18.6	17.5
600LMF	22.6	22.9	15.8	21.5	19.6	10.7	10.6	22.6	21.6	19.9	18.8
800LMF	23.7	24	17	22.6	20.7	11.8	11.7	23.7	22.7	21	19.9
1000LMF	24.4	24.7	17.7	23.3	21.4	12.5	12.4	24.4	23.4	21.7	20.6
1200LMF	25.1	25.4	18.4	24	22.1	13.2	13.1	25.1	24.1	22.4	21.3
1400LMF	25.5	25.9	18.8	24.5	22.5	13.6	17.9	13.6	24.5	22.9	21.8
1500LMF	25.8	26.1	19	24.7	22.8	13.9	13.8	25.8	24.8	23.1	22
Lumen Package	Endwise										
	Lambertian	CLL	WW	WG	DBW	LVRR	LVRRA	EGLD	DPR05	DRP1	DRP15
300LMF	20	19.7	15.7	18.4	18.6	12.6	12.5	19.9	21.5	21.6	21.6
400LMF	21	20.7	16.7	19.4	19.7	9.4	9.3	20.9	22.5	22.6	22.7
600LMF	22.4	22.1	18.1	20.7	21	14.9	14.8	22.2	23.8	23.9	24
800LMF	23.5	23.2	19.2	21.8	22.1	16	16	23.3	24.9	25	25.1
1000LMF	24.2	23.9	19.9	22.5	22.8	16.7	16.7	24.1	25.6	25.7	25.8
1200LMF	24.9	24.6	20.6	23.2	23.5	17.4	17.4	24.8	26.3	26.4	26.5
1400LMF	25.3	25	21	23.7	23.9	17.9	17.8	25.2	26.8	26.9	27
1500LMF	25.6	25.2	21.3	23.9	24.2	18.1	18	25.4	27	27.1	27.2

*Calculations based on a 4 foot fixture @ 35K 80CRI
**UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR" and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire
*** Click here from more information: UGR FAQ

marklighting.com | 800-705-SERV (7378) | © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

LINEAR PLAN

Mark Lighting offers the ability to provide a continuous run plan to suit your requirements by optionally offering three different methods of configuration.

LLP- Linear Longest Possible
In this configuration, the longest length available is optimized, resulting in the fewest segments and mounting locations. Caution should be used where balanced appearance is a concern. Example: 20 FT run would have 2, 8 FT segments and 1, 4 FT segment at the end of the run.

LLP	8 FT	8 FT	4FT

LCB- Linear Center Balanced:
This configuration incorporates the longest center segment(s) along with any additional lengths required to fill the run length, added to the run ends. Example: 16 FT run would have 2, 4 FT segments (one at each end) and 1, 8 FT segment in the center.

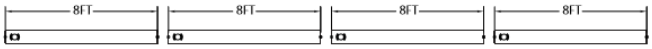
LCB	4 FT	8 FT	4FT

LSL- Linear Same Length:
In this configuration, each segment is the same length and is standardized based on the longest length available and is the only option provided. Because it is dependent on one segment length and there are mathematical limitations on what overall row lengths can be achieved. Example: 20 FT row would be achieved with 5, 4 FT long segments equaling 20 FT (nominal).

LSL	4FT	4FT	4FT	4FT	4FT

Total Run Length
This system is not modular. Runs longer that 8FT will be automatically configured with left, intermediate and right sections, based on how you specify the TOTAL RUN LENGTH and MAXIMUM SECTION LENGTH parameters in the ordering information. Always order the total run length, not the individual sections.

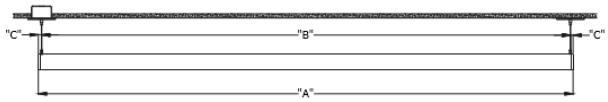
Example: This run must be ordered as 1pc "S4PD LLP 32FT MSL8..."



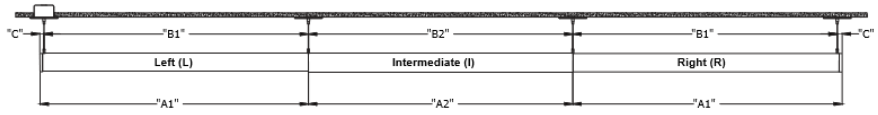
Example: If you order as 4pcs "S4PD LLP 8FT MSL8... you will receive these INDIVIDUAL sections that cannot be joined together

Maximum Section Length
The run will be broken out using as many sections at the chosen maximum section length as possible. Shorter sections will then complete the desired run length.

Examples:
S4PD LLP 21FT MSL5... = 5FT / 4FT / 4FT / 4FT / 4FT
S4PD LLP 21FT MSL6... = 6FT / 6FT / 5FT / 4FT
S4PD LLP 21FT MSL7... = 7FT / 7FT / 7FT
S4PD LLP 21FT MSL8... = 8FT / 8FT / 5FT



INDIVIDUAL FIXTURES				
ORDERED LENGTH	"A" O.A.L.	"B" O.C.	"C" FROM END	APPROX. WEIGHT
2FT	2'- 0 9/16"	1'- 11 13/16"	3/8"	2
3FT	3'- 0 9/16"	2'- 11 13/16"	3/8"	3
4FT	4'- 0 9/16"	3'- 11 13/16"	3/8"	4
5FT	5'- 0 9/16"	4'- 11 13/16"	3/8"	5
6FT	6'- 0 9/16"	5'- 11 13/16"	3/8"	6
7FT	7'- 0 9/16"	6'- 11 13/16"	3/8"	7
8FT	8'- 0 9/16"	7'- 11 13/16"	3/8"	8

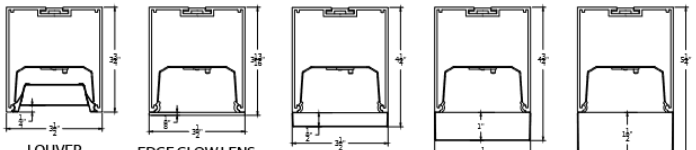


RUN LAYOUT						
ORDERED LENGTH	"A1" O.A.L.	"A2" O.A.L.	"B1" O.C.	"B2" O.C.	"C" FROM END	APPROX. WEIGHT
4FT	4'- 0 1/4"	4'-0"	3'- 11 15/16"	4'-0"	3/8"	4
5FT	5'- 0 1/4"	5'-0"	4'- 11 15/16"	5'-0"	3/8"	5
6FT	6'- 0 1/4"	6'-0"	5'- 11 15/16"	6'-0"	3/8"	6
7FT	7'- 0 1/4"	7'-0"	6'- 11 15/16"	7'-0"	3/8"	7
8FT	8'- 0 1/4"	8'-0"	7'- 11 15/16"	8'-0"	3/8"	8

marklighting.com | 800-705-SERV (7378) | © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

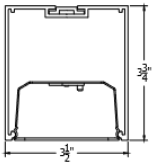
SHIELDING, OPTICS & CONNECTORS

Direct Shielding



LOUVER | EDGE GLOW LENS | 1/2" DROP LENS | 1" DROP LENS | 1-1/2" DROP LENS

Direct Optics

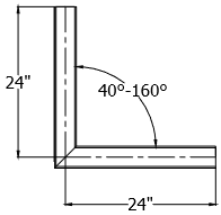


CO-EXTRUDED LENS

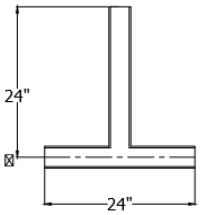
Optical Film with Co-Extruded Lens (Batwing (DBW), Wall Graze (WG), Wall Wash (WW))

Run Patterns, Corners and Junction

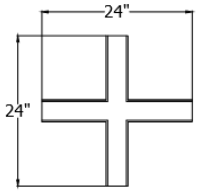
Patterns can be configured in 1' increments with illuminated L, T & X connectors with standard 2' corner. L connectors are available in 40-160 degrees in 1 degree increments. T & X connectors available in 90 degrees. For custom angles, corner or junction lengths, consult factory.
See separate pattern spec sheet for more details.



L Connector



T Connector



X Connector

marklighting.com | 800-705-SERV (7378) | © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

MARK
ARCHITECTURAL
LIGHTING™

SLOT 4
Pendant Direct

MOST COMMON MOUNTING TYPES AND OPTIONS
Options available for this specific luminaire are checked in the boxes below.

Mounting Type

F1/* For use with most T-Bar and screw slot grid ceilings. Designed for on-grid and off-grid applications. (J-box by others)

F1A/* For use with most T-Bar grid ceilings. Designed for on-grid applications. *Comes complete with J-box with built-in cutout to go over grid*

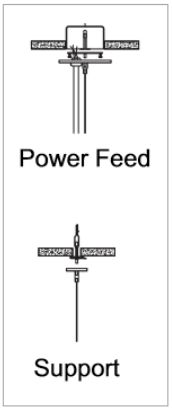
F2/ For use with recessed or surface mount horizontal J-box applications. (J-box by others)

Mounting Options

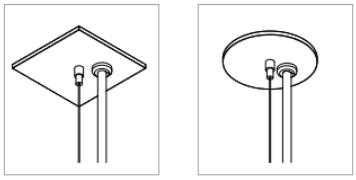
MCS MCS canopy supplies 5" canopy to match feed point canopy size. Matching canopy at support for aesthetics.

PIF Feed cord installed in fixture.

*For use with flush ceiling tiles only. For tegular ceiling tiles, purchase of new universal bracket with longer bolt is required. (*249E5A)

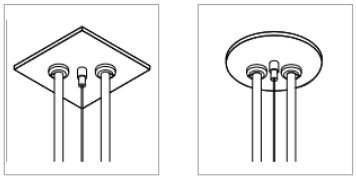


Mounting with Feed (SPSW1FK)



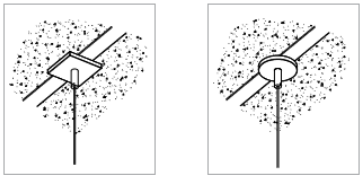
5" Square | 5" Round

Mounting with Dual Feed (SPSW2FK)



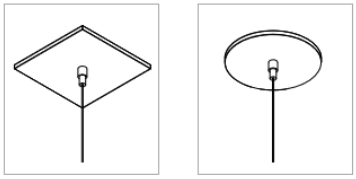
5" Square | 5" Round

Mounting Support (SPSWSK)



2" Square | 2" Round

MCS Option



5" Square | 5" Round

INTELLIGENT LUMINAIRE TECHNOLOGY GUIDE

Choose nomenclature from these columns

Driver Configurations

Minimum Dimming Level		Control Input	Dimming Range	Notes
NO DIM	+	(blank)	-	No 0-10V leads from the driver.
MIN10	+	ZT	100 to 10%	
MIN1	+	ZT	100 to 1%	
MIN1	+	NLIGHT	100 to 1%	
MIN1		ECOD	100 to 1%	Lutron Hi-lume 1% EcoSystem LED Driver with Soft-on, Fade-to-Black (model LDE1)
DARK		ZT	100 to 0.1%	
DARK		NLIGHT	100 to 0.1%	
DARK		DALI	100 to 0.1%	"Compatible with DALI. Formerly (EDB & EDAB) nomenclature." Logarithmic dimming

Choose nomenclature from these columns

Control / Sensor Configurations

Control Input		Sensor		Sensor	Notes
ZT	+	ADC	=	MSD ADC	Automatic dimming control integral photocell.
ZT	+	PDT	=	MSD PDT 7	Dual technology integral occupany sensor.
ZT	+	APIR	=	MSD 7 ADC	PIR integral occupancy sensor with automatic dimming control photocell.
ZT	+	APDT	=	MSD PDT 7 ADC	Dual technology integral occupany sensor with automatic dimming control photocell.
NLIGHT	+	(blank)	=	nIO EZ PH	nLight enabled only. No onboard sensor.
NLIGHT	+	ADC	=	nIO EZ PH + nES ADCX	Automatic dimming control integral photocell. nLight enabled.
NLIGHT	+	PDT	=	nIO EZ PH + nES PDT 7	360° Dual technology integral occupany sensor. nLight enabled.
NLIGHT	+	APIR	=	nIO EZ PH + nES 7 ADCX	360° PIR integral occupancy sensor with automatic dimming control photocell. nLight enabled.
NLIGHT	+	APDT	=	nIO EZ PH + nES PDT 7 ADCX	360° Dual technology integral occupancy sensor with automatic dimming control photocell. nLight enabled.
NLTAIR2	+	(blank)	=	RIO EZDL EXT900 ACWH 90D G2	nLight AIR enabled only. No onboard sensor.
NLTAIR2	+	APIR	=	RES7 EXT900 ACWH 90D G2	PIR integral occupancy sensor with automatic dimming control photocell. nLight AIR enabled.
NLTAIR2	+	APDT	=	RES7 PDT EXT900 ACWH 90D G2	Dual technology integral occupany sensor with automatic dimming control photocell. nLight AIR enabled.

For more information, please consult our technical guides for nLight or nLight Air.

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

nLight® Wired Control Accessories
Order as separate catalog number

Wall Switches	Model Number
On/Off single pole	nPODMA (color)
On/Off two pole	nPODMA 2P (color)
On/Off single pole, dimming	nPODMA DX (color)
On/Off two pole, dimming	nPODMA 2P DX (color)
On/Off, two level	nPODMA 2L (color)
Graphic touchscreen	nPOD TOUCH (color)

For more information see nPOD and nPOD TOUCH spec sheets

nLight AIR® Control Accessories
Order as separate catalog number

Wall Switches	Model Number
On/Off single pole	rPODBA (color)
On/Off two pole	rPODBA 2P (color)
On/Off single pole, dimming	rPODBA DX (color)
On/Off two pole, dimming	rPODBA 2P DX (color)
On/Off, 4 scene control	rPODBA 4S (color)

For more information see rPOD spec sheets

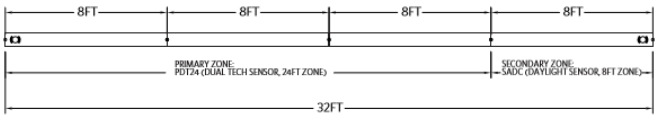
marklighting.com | 800-705-SERV (7378) | © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

INTEGRATED SENSOR LAYOUT

For runs longer than 8FT:
ALWAYS order the run by the TOTAL RUN LENGTH. Ordering the sections individually will not provide the correct joining hardware to allow connection in the field.

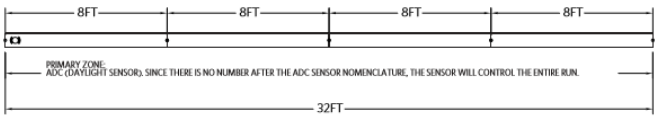
CORRECT:

32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 24FT AND SECONDARY ZONE 8FT -- PDT24 SADC8



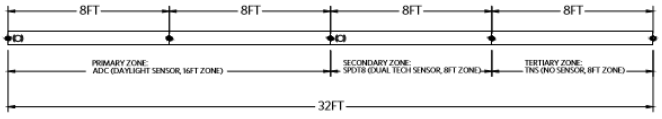
Total Run Length to Order

32FT MSL8 RUN WITH 1 SENSOR ALL ONE ZONE -- ADC



Total Run Length to Order

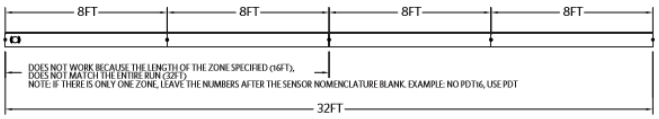
32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 16FT, SECONDARY ZONE 8FT, AND TERTIARY ZONE 8FT-- ADC16 SPDT8 TNS8



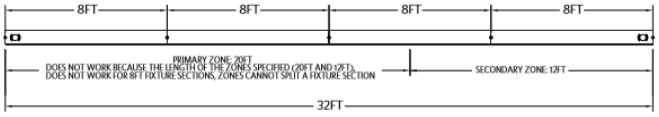
Total Run Length to Order

INCORRECT:

32FT MSL8 RUN WITH 1 SENSOR ALL ONE ZONE -- PDT16



32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 20FT AND SECONDARY ZONE 12FT -- PDT20 SADC12



Notes:
- Only one sensor per zone
- At the most, the entire run can only have 2 sensors (thus 2 sensors zones at the most)
- Sensor zone can not split fixture sections
- No overlapping zones

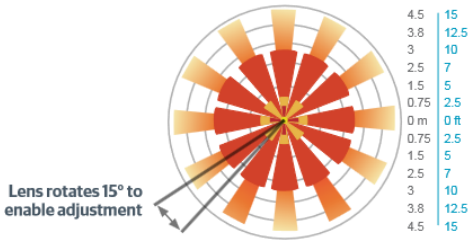
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

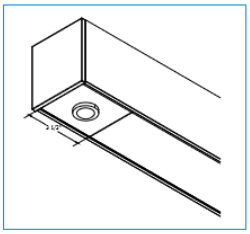
Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.

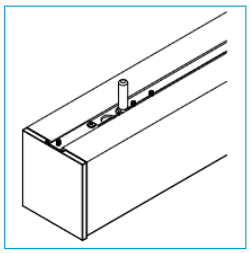


Integrated Controls
Optional nLight® integrated controls make Slot LED luminaires addressable- allowing them to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling (included).



Occupancy Sensor and/or Photocell

nLight Air Wireless Antenna Location
Note: Antenna will be shipped separately and will need to be attached to the coax connector.

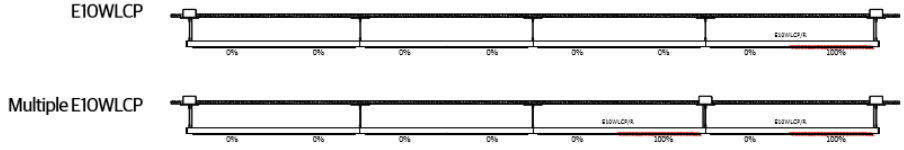


 © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

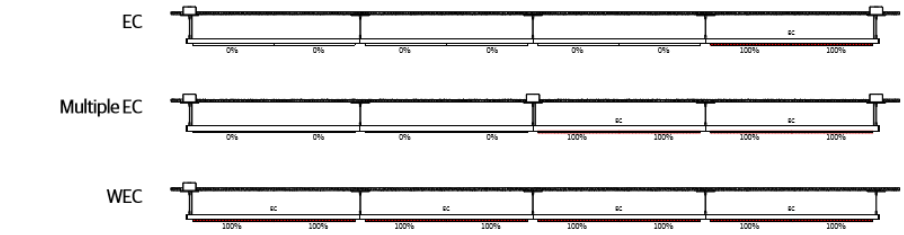
EMERGENCY OPTIONS

Emergency Battery Packs

The PS1055LCP battery is integral to the fixture and comes standard with test switch and self-diagnostics.
Only direct light portion operated by emergency, as indicated below.



Emergency Circuits



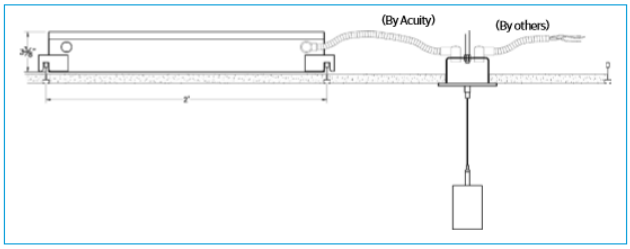
Note: *Whole run on emergency circuit (Not available with NLIGHT or NLTAIR2)*

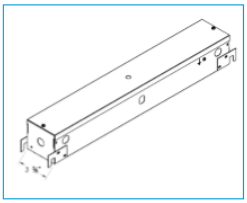
How to Estimate Delivered Lumens in Emergency Mode
Use the formula below to estimate the delivered lumens in emergency mode
Delivered Lumens = 1.25 x P x LPW
P = 10W for PS1055LCP
LPW = Lumen per watt rating of the luminaire This information is available on page 1 of this spec sheet or appropriate IES file.

Section Length	E10WLCP	EC
U2	None	Entire unit
U3	None	Entire unit
U4	Entire unit	Entire unit
U5	Last 3'	Entire unit
U6	Last 3'	Entire unit
U7	Last 4'	Entire unit
U8	Last 4'	Entire unit

Remote GTD Mounting Option

Recessed in ceiling. Consult factory for other ceiling types or canopy options.
6 foot flexible conduit included, GTD option should be mounted within 6 feet of junction box above fixture.





Accessible Ceiling

marklighting.com | 800-705-SERV (7378) | © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

SPECIFICATIONS

Housing
One-piece extruded aluminum housing

Finish
Standard colors for fixtures and end caps are polyester powder coated white, black, or silver with satin sheen. Consult factory for custom colors and RAL color options.

Optics (Distribution)
Wall Wash (WW), Wall Graze (WG), and Direct Batwing (DBW) incorporate co-extruded lenses and films.

Lenses/Shielding
Direct: Extruded acrylic lens, (FLL, CLL). Edge Glow lens, (EGLD), Aluminum baffle with either a powder coat finish (LVRR) or aluminum finish (LVRRA). Extruded acrylic drop lens (DRP05, DRP1, DRP15).

LED Components
Multiple lumen packages available with 2700K, 3000K, 3500K, 4000K and 5000K CCT. The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. The color a variation of no greater than a 2.5 Step MacAdam (2.55DECM) along the black body locus from board to board.

Electrical
Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 90% LED lumen maintenance at 60,000 hours (L90/60,000).

Circuits
Single and dual switching options available. Dual switching offered with shared neutral.

Controls System Networking Options
Optional integrated nLight® controls make each fixture addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors, and photocontrols. Connection to nLight is simple. It can be accomplished with remote nLight AIR wireless or through standard Cat-5 cabling. (cabling "by others") nLight offers unique plug-and-play convenience as devices and luminaires automatically discover each other, while nLight AIR is commissioned easily through an intuitive mobile app.

Emergency Battery (Optional)
Integral emergency battery (E10WLCP) for 90 minutes of operation. Emergency battery pack, 10W, Linear Constant Power Certified in CA Title 20 MAEDBS.

Remote generator transfer device (GTD) works in conjunction with an auxiliary generator or a central inverter system to power fixtures for safe egress lighting.

Dimming Drivers
Factory tuned constant current electronic dimming driver is standard. Flicker free dimming available down to <1%. LED drivers perform within the recommended operating areas for flicker as a function of frequency and modulation (%) IEEE Standard 1789-2015 (IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers), in typical operating conditions at representative dimming levels. Electrical specifications at maximum driver load: PF > 0.9 and THD <20%. Meets FCC Title 47 Class A or Class B. Other available drivers include Lutron and DALI protocol drivers. All drivers are RoHS compliant.

Environment
Suitable for damp location. Indoor use only.

Certification
CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750).

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Ambient Operating Temperature
-20°C (-4° F) to +25°C (+77°F).

Government Procurement
BAA – Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

Fixture Weight
1 lbs per foot, less packaging.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: *Actual performance may differ as a result of end-user environment and application.*
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

marklighting.com | 800-705-SERV (7378) | © 2022-2025 Acuity Brands Lighting, Inc. All Rights Reserved. We reserve the right to change design, materials and finish in any way that will not alter installed appearance or reduce function and performance.

EQUIPMENT

MANUFACTURER	Color Kinetics
CATALOG NUMBER	423-000034-30
TOTAL WATTS	33.2
VOLTAGE	100-277
MOUNTING	Surface
WEIGHT	4.41 lb
DIMENSIONS	48.06" x 1.77" x 1.66"
FINISH	
RATING	IP66
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	Intelihue
CRI	
LUMEN OUTPUT	2220
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	Contractor

ACCESSORIES

Surface mount adjustable linear with one (1) LED lighting source, 2220 delivered lumens, Intelihue color engine, 30° x60° optic and remote driver. Linear should operate on 100 -277 voltage and be supplied with a dmx control option. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Linear to be rated for IP66 or equivalent. Linear should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Graze Compact Powercore gen2

Date:
Type:
Firm Name:
Project:

IntelliHue, High Power, 30° x 60°, 1219 mm (4 ft)

L71
423-000034-30

Exterior compact linear grazing luminaire with intelligent white and color light

Graze Compact is a high-performance, exterior linear luminaire designed to highlight architectural features like molding details, archways and windows up to two stories high. Graze Compact IntelliHue utilizes Color Kinetics IntelliHue technology to produce millions of saturated colors, pastels, and high-quality white light, in the same precisely controllable luminaire. Multiple luminaire lengths and beam angles support a large range of façade or surface illumination applications. The brand new low-profile housing, connectorized cabling, a universal power input range, and direct line voltage make Graze Compact luminaires easy to install and operate.

- Tailor light output to specific applications—Available in four standard lengths (1, 2, 3, and 4 ft), and three standard 10° x 60°, 30° x 60°, and 60° x 60° beam angles.
- Ultra compact form factor—Graze Compact's ultra-low profile is half the size of Graze, allowing it to fit discretely into almost any layout, from simple to elaborate.
- Innovative optical design features fully mixed light directly out of the luminaire. This allows for smaller setbacks than many other luminaires.
- Color-changing and high-quality white light from the same luminiare—IntelliHue is an advanced approach to color mixing that enables high-quality intelligent color and white light from a single luminaire. Multiple channels of LED light sources combine to produce a full spectrum of precisely controllable light, including millions of saturated colors, pastels, and uniform white light with CRI of greater than 80 in the 2700 K to 4000 K range.
- Improve color consistency between all LED luminaires in a family with Chromasync technology. During the manufacturing process a calibrated light measurement device creates an algorithm to define a common color gamut for an entire family of LED luminaires. When Chromasync is enabled, color consistency between luminaires is achieved without having to manually adjust color points on each luminaire.
- Integrates patented Powercore technology that controls power output to luminaires directly from line voltage – rapidly, efficiently, and accurately. The Color Kinetics Data Enabler Pro merges line voltage with control data and delivers them to luminaires over a single standard cable, dramatically simplifying installation and lowering total system cost.
- Graze Compact provides years of reliable use under rugged conditions. Graze Compact raises reliability even further with more protection from corrosion by meeting ASTM B117 standard and ANSI C136.31-2010 standard with a 3G vibration rating.
- Works seamlessly with the Color Kinetics full range of controllers, including iPlayer 3, iPlayer 4, Antumbra iColor Keypad, and ColorDial Pro—as well as third-party controllers.
- Convenient push-and-click connectors let you easily and rapidly install Leader Cables and Jumper Cables. Constant torque locking hinges offer simple and consistent position control from various angles.
- Customizable accessories - Customize your Graze luminaire with a choice of accessories: mounting arm, masking shield, symmetric louver, and masking tray. Mounting arm available in three sizes.

For detailed product information, please refer to the Graze Compact Product Guide at www.colorkinetics.com/global/products/intellihue/graze-compact-powercore-gen2

COLORKINETICS

Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Output

Beam Angle	30° x 60°
Lumens 2700 K †	2072
Lumens 3000 K	2042
Lumens 3500 K	2036
Lumens 4000 K	2024
Lumens 5000 K	1960
Lumens 6500 K	1936
Lumens per channel	R 884 / G 1664 / B 428 / MW 1812
Efficacy (lm/W) §§	62
CRI @ 3500 K	90
LED Channels	Red/Green/Blue/Mint White

Electrical

Input Voltage	100 to 277 VAC, auto-ranging, 50/60 Hz
Power Consumption (Maximum at full output, steady state)	33.6 W
Surge Limits ¶	2 kV maximum differential (L to N) 4 kV maximum common (L to Gnd or N to Gnd)

For additional Surge Protection Requirements for LED Lighting Systems, please refer to www.colorkinetics.com/KB/surge-protection.

Control

Interface	Data Enabler Pro (DMX or Ethernet)
Control Channels	4 channels per 1 ft section

For additional Control Channel information, please refer to https://colorkinetics.helpdocs.io/article/fv5rkpvclq.

Control System

Works seamlessly with the Color Kinetics full range of controllers, including iPlayer 3, iPlayer 4, Antumbra iColor Keypad, and ColorDial Pro—as well as third-party controllers.

Remote Monitoring & Management Works with Interact Landmark

Lumen Maintenance

Threshold§	Ambient Temperature	Reported ¶¶	Calculated ¶¶
L_{90}	25 °C	> 39,715	> 39,715
	50 °C	> 39,715	> 39,715
L_{80}	25 °C	> 55,000	> 98,607
	50 °C	> 55,000	> 98,607
L_{70}	25 °C	> 55,000	> 100,000
	50 °C	> 55,000	> 100,000
L_{50}	25 °C	-	> 100,000
	50 °C	-	> 100,000

Physical

Dimensions (Height x Width x Depth)	45.05 x 1260.65 x 42.2 mm (1.77 x 48.06 x 1.66 in)
Weight	2 kg (4.41 lb)
Housing Material	Extruded anodized aluminium
Lens	Glass
Luminaire Connections	Integral male/female waterproof connectors
Mounting	Multi-positional, constant torque locking hinges

Temperature Ranges

-40 to 50 °C (-40 to 122 °F) Operating
-20 to 50 °C (-4 to 122 °F) Startup
-40 to 80 °C (-40 to 176 °F) Storage

Vibration Resistance

Complies with ANSI C136.31, 3G

Mechanical Impact	IK07 (IK06 2ft and 3ft)

Corrosion Resistance

Complies with ASTM B117 standard for > 1,500 hours

Humidity	0 to 95%, non-condensing

Thermal Protection enabled

For additional Thermal Protection information, please refer to https://colorkinetics.helpdocs.io/article/sh301ducix

Luminaire Run Lengths

To calculate luminaire run lengths and total power consumption for your specific installation, download the Configuration Calculator from www.colorkinetics.com/support/install_tool/

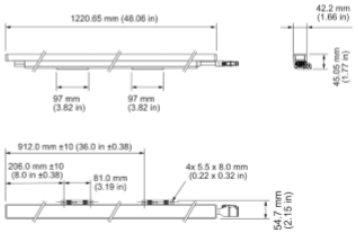
Certification and Safety

Approbation	UL/cUL, FCC Class A, PSE, CE, CQC, RCM, EAC, BIS, UA
Environment	Dry/Damp/Wet Location, IP66

For additional Energy Efficiency Class Information, please refer to https://colorkinetics.helpdocs.io/article/cviis2p8qq.

† 305 mm (1 ft) 2700 K lumen output measurements comply with IES LM-79-08 testing procedures. All other measurements including 610 mm (2 ft), 914 mm (3 ft), and 1219 mm (4 ft) lengths are estimated based on the 305 mm (1 ft) 2700 K measurements.
§ Lxx = xx% lumen maintenance (when light output drops below xx% of initial output). All values are given at B10, or the median value where 90% of the LED population is better than the reported or calculated lumen maintenance measurement.
¶ Minimum surge limits per IEC 61547, tested in accordance with IEC 61000-4-5.
§§ Efficacy measurements are estimated based on the 305 mm (1 ft) measurements.
¶¶ Lumen maintenance figures are based on lifetime prediction graphs supplied by LED source manufacturers. Whenever possible, figures use measurements that comply with IES LM-80-08 testing procedures. In accordance with TM-21-11, Reported values represent the interpolated value based on six times the LM-80-08 total test duration (in hours). Calculated values represent time durations that exceed six times the total test duration.

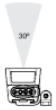
Dimensions



Photometrics High Power, 3500 K, 30° x 60° beam angle, 305 mm (1 ft)

Photometric data is based on full hemisphere testing to IES standards.

Beam Angle	30° x 60°
LED	All Channels On
Lumens	570.0
Efficacy (lm/W)	62



Illuminance at Distance

	Center Beam fc	Beam Width	
4 ft	35.5 fc	7.3 ft	1.9 ft
8 ft	8.9 fc	14.5 ft	3.8 ft
12 ft	3.9 fc	21.8 ft	5.7 ft
16 ft	2.2 fc	29.0 ft	7.6 ft
20 ft	1.4 fc	36.3 ft	9.5 ft
24 ft	1.0 fc	43.6 ft	11.5 ft

7.2 m (23.9 ft)
1 fc maximum distance

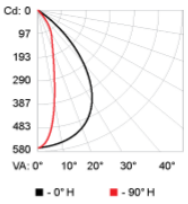
Vert. Spread: 84.4°
Horiz. Spread: 26.9°

Zonal Lumen

Zone	Lumens	% Luminaire
0-30	268.9	52.8%
0-40	376.7	74.0%
0-60	489.3	96.1%
60-90	18.7	3.7%
70-100	5.3	1.0%
90-120	0.1	0.0%
0-90	508.0	99.8%
90-180	1.0	0.2%
0-180	509.0	100.0%

For lux multiply fc by 10.7

Polar Candela Distribution



	0	25	45	70	90
0	568	568	568	568	568
5	560	551	537	523	521
15	533	459	352	266	250
25	481	333	191	141	135
35	367	216	118	87	84
45	186	115	67	46	43
55	53	42	29	22	21
65	12	12	11	10	10
75	4	4	3	4	4
85	1	0	0	0	0
90	0	0	0	0	0

Coefficents of Utilization – Zonal Cavity Method

Effective Floor Cavity Reflectance: 20%

RCC %:	80				70				50			30		10	0
RW %:	70	50	30	0	70	50	30	0	50	30	20	50	30	20	50	30	20	0
RCR:																		
0	1.19	1.19	1.19	1.19	1.16	1.16	1.16	1.00	1.11	1.11	1.11	1.06	1.06	1.06	1.02	1.02	1.02	1.00
1	1.12	1.08	1.06	1.04	1.10	1.07	1.04	0.92	1.05	1.01	0.99	0.99	0.97	0.96	0.95	0.94	0.93	0.91
2	1.05	1.00	0.95	0.91	1.03	0.98	0.94	0.83	0.95	0.91	0.88	0.91	0.89	0.86	0.89	0.86	0.84	0.82
3	0.98	0.91	0.85	0.81	0.97	0.90	0.84	0.76	0.87	0.83	0.79	0.85	0.81	0.77	0.82	0.79	0.76	0.74
4	0.91	0.84	0.77	0.72	0.91	0.83	0.77	0.69	0.80	0.75	0.71	0.78	0.74	0.70	0.76	0.73	0.69	0.68
5	0.87	0.77	0.71	0.66	0.85	0.76	0.70	0.63	0.74	0.69	0.65	0.73	0.68	0.64	0.71	0.67	0.63	0.62
6	0.82	0.72	0.65	0.60	0.80	0.71	0.64	0.58	0.69	0.63	0.59	0.68	0.63	0.59	0.66	0.62	0.58	0.57
7	0.77	0.67	0.60	0.55	0.76	0.66	0.59	0.54	0.65	0.59	0.54	0.63	0.58	0.54	0.62	0.57	0.54	0.52
8	0.73	0.62	0.56	0.51	0.72	0.62	0.55	0.50	0.60	0.54	0.50	0.59	0.54	0.50	0.58	0.53	0.50	0.48
9	0.68	0.58	0.52	0.47	0.68	0.58	0.51	0.46	0.57	0.51	0.47	0.56	0.50	0.47	0.55	0.50	0.46	0.45
10	0.66	0.55	0.48	0.44	0.64	0.54	0.48	0.43	0.53	0.48	0.44	0.52	0.47	0.43	0.52	0.47	0.43	0.42

Luminaire and Accessories

Use Item Number when ordering in North America

Luminaire	Item Number	Item 12NC
Graze Compact Powercore gen2, IntelliHue, High Power, 30° x 60°, 1219 mm (4 ft) Includes Luminaire, Hinge(s), and Tether Anchor.	423-000034-30	912400137853
Accessories		
Graze Compact Powercore Jumper Cable, 1 ft, CE/CQC	108-000073-01	912400136931
Graze Compact Powercore Jumper Cable, 5 ft, CE/CQC	108-000073-03	912400136933
Graze Compact Powercore Jumper Cable, 1 ft, UL	108-000073-00	912400136930
Graze Compact Powercore Jumper Cable, 5 ft, UL	108-000073-02	912400136932
Graze Compact Powercore Leader Cable, 10 ft, CE/CQC	108-000074-01	912400136941
Graze Compact Powercore Leader Cable, 10 ft, UL	108-000074-00	912400136940
Graze Compact Constant Torque Hinge, (Set of 10)	120-000211-00	912400136664
Graze Compact Masking Tray, 1219 mm, 4 ft	120-000209-03	912400136659
Graze Compact Masking Tray End Plate, (Pair)	120-000209-04	912400137116
Architectural Mounting Arm, Short, Gray	120-000206-00	912400136642
Architectural Mounting Arm, Medium, Gray	120-000206-01	912400136643
Architectural Mounting Arm, Long, Gray	120-000206-02	912400136644
Graze Compact Symmetric Louver, 1219 mm, 4 ft	120-000207-03	912400136651
Graze Compact Tether Anchor, (Set of 10)	120-000211-01	912400136665
Graze Compact Masking Shield, 1219 mm, 4 ft	120-000216-04	912400137229
Power Supplies		
Data Enabler Pro, 3/4 in / 1/2 in NPT (U.S. trade size conduit)	106-000004-00	910503701210
Data Enabler Pro, PG21/PG13 (metric size conduit)	106-000004-01	910503701211

COLORKINETICS

© 2024 Signify Holding. All rights reserved. Specifications are subject to change without notice. No representation or warranty as to the accuracy or completeness of the information included herein is given and any liability for any action in reliance thereon is disclaimed.

08/06/2024

Color Kinetics
www.colorkinetics.com/global/products/intellihue/graze-compact-powercore-gen2

EQUIPMENT

MANUFACTURER	Color Kinetics
CATALOG NUMBER	423-000034-18
TOTAL WATTS	8.4
VOLTAGE	100-277
MOUNTING	Surface
WEIGHT	
DIMENSIONS	12” x 1.77” x 1.66”
FINISH	
RATING	IP66
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	Intelihue
CRI	
LUMEN OUTPUT	518
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	Contractor

ACCESSORIES

Surface mount adjustable linear with one (1) LED lighting source, 518 delivered lumens, Intelihue color engine, 30°x60° optic and remote driver. Linear should operate on 100-277 voltage and be supplied with a dmx control option. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Linear to be rated for IP66 or equivalent. Linear should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Graze Compact Powercore gen2

Date:
Type:
Firm Name:
Project:

IntelliHue, High Power, 30° x 60°, 305 mm (1 ft)

L71A
423-000034-18

Exterior compact linear grazing luminaire with intelligent white and color light

Graze Compact is a high-performance, exterior linear luminaire designed to highlight architectural features like molding details, archways and windows up to two stories high. Graze Compact IntelliHue utilizes Color Kinetics IntelliHue technology to produce millions of saturated colors, pastels, and high-quality white light, in the same precisely controllable luminaire. Multiple luminaire lengths and beam angles support a large range of façade or surface illumination applications. The brand new low-profile housing, connectorized cabling, a universal power input range, and direct line voltage make Graze Compact luminaires easy to install and operate.

- Tailor light output to specific applications—Available in four standard lengths (1, 2, 3, and 4 ft), and three standard 10° x 60°, 30° x 60°, and 60° x 60° beam angles.
- Ultra compact form factor—Graze Compact's ultra-low profile is half the size of Graze, allowing it to fit discretely into almost any layout, from simple to elaborate.
- Innovative optical design features fully mixed light directly out of the luminaire. This allows for smaller setbacks than many other luminaires.
- Color-changing and high-quality white light from the same luminiare—IntelliHue is an advanced approach to color mixing that enables high-quality intelligent color and white light from a single luminaire. Multiple channels of LED light sources combine to produce a full spectrum of precisely controllable light, including millions of saturated colors, pastels, and uniform white light with CRI of greater than 80 in the 2700 K to 4000 K range.
- Improve color consistency between all LED luminaires in a family with Chromasync technology. During the manufacturing process a calibrated light measurement device creates an algorithm to define a common color gamut for an entire family of LED luminaires. When Chromasync is enabled, color consistency between luminaires is achieved without having to manually adjust color points on each luminaire.
- Integrates patented Powercore technology that controls power output to luminaires directly from line voltage – rapidly, efficiently, and accurately. The Color Kinetics Data Enabler Pro merges line voltage with control data and delivers them to luminaires over a single standard cable, dramatically simplifying installation and lowering total system cost.
- Graze Compact provides years of reliable use under rugged conditions. Graze Compact raises reliability even further with more protection from corrosion by meeting ASTM B117 standard and ANSI C136.31-2010 standard with a 3G vibration rating.
- Works seamlessly with the Color Kinetics full range of controllers, including iPlayer 3, iPlayer 4, Antumbra iColor Keypad, and ColorDial Pro—as well as third-party controllers.
- Convenient push-and-click connectors let you easily and rapidly install Leader Cables and Jumper Cables. Constant torque locking hinges offer simple and consistent position control from various angles.
- Customizable accessories - Customize your Graze luminaire with a choice of accessories: mounting arm, masking shield, symmetric louver, and masking tray. Mounting arm available in three sizes.

For detailed product information, please refer to the Graze Compact Product Guide at www.colorkinetics.com/global/products/intellihue/graze-compact-powercore-gen2

COLORKINETICS

Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Output

Beam Angle	30° x 60°
Lumens 2700 K †	518
Lumens 3000 K	512
Lumens 3500 K	509
Lumens 4000 K	506
Lumens 5000 K	490
Lumens 6500 K	484
Lumens per channel	R 221 / G 416 / B 107 / MW 453
Efficacy (lm/W) §§	62
CRI @ 3500 K	90
LED Channels	Red/Green/Blue/Mint White

Electrical

Input Voltage	100 to 277 VAC, auto-ranging, 50/60 Hz
Power Consumption (Maximum at full output, steady state)	8.4 W
Surge Limits ¶	2 kV maximum differential (L to N) 4 kV maximum common (L to Gnd or N to Gnd)

For additional Surge Protection Requirements for LED Lighting Systems, please refer to www.colorkinetics.com/KB/surge-protection.

Control

Interface	Data Enabler Pro (DMX or Ethernet)
Control Channels	4 channels per 1 ft section

For additional Control Channel information, please refer to https://colorkinetics.helpdocs.io/article/fv5rkpvclq.

Control System

Works seamlessly with the Color Kinetics full range of controllers, including iPlayer 3, iPlayer 4, Antumbra iColor Keypad, and ColorDial Pro—as well as third-party controllers.

Remote Monitoring & Management Works with Interact Landmark

Lumen Maintenance

Threshold§	Ambient Temperature	Reported ¶¶	Calculated ¶¶
L_{90}	25 °C	> 39,715	> 39,715
	50 °C	> 39,715	> 39,715
L_{80}	25 °C	> 55,000	> 98,607
	50 °C	> 55,000	> 98,607
L_{70}	25 °C	> 55,000	> 100,000
	50 °C	> 55,000	> 100,000
L_{50}	25 °C	-	> 100,000
	50 °C	-	> 100,000

Physical

Dimensions (Height x Width x Depth)	45.05 x 306.3 x 42.2 mm (1.77 x 12.06 x 1.66 in)
Weight	0.68 kg (1.5 lb)
Housing Material	Extruded anodized aluminium
Lens	Glass
Luminaire Connections	Integral male/female waterproof connectors
Mounting	Multi-positional, constant torque locking hinges

Temperature Ranges

-40 to 50 °C (-40 to 122 °F) Operating
-20 to 50 °C (-4 to 122 °F) Startup
-40 to 80 °C (-40 to 176 °F) Storage

Vibration Resistance

Complies with ANSI C136.31, 3G

Mechanical Impact	IK07 (IK06 2ft and 3ft)

Corrosion Resistance

Complies with ASTM B117 standard for > 1,500 hours

Humidity	0 to 95%, non-condensing

Thermal Protection enabled

For additional Thermal Protection information, please refer to https://colorkinetics.helpdocs.io/article/sh301ducix

Luminaire Run Lengths

To calculate luminaire run lengths and total power consumption for your specific installation, download the Configuration Calculator from www.colorkinetics.com/support/install_tool/

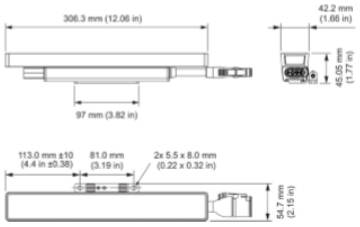
Certification and Safety

Approbation	UL/cUL, FCC Class A, PSE, CE, CQC, RCM, EAC, BIS, UA
Environment	Dry/Damp/Wet Location, IP66

For additional Energy Efficiency Class Information, please refer to https://colorkinetics.helpdocs.io/article/cviis2p8qq.

† 305 mm (1 ft) 2700 K lumen output measurements comply with IES LM-79-08 testing procedures. All other measurements including 610 mm (2 ft), 914 mm (3 ft), and 1219 mm (4 ft) lengths are estimated based on the 305 mm (1 ft) 2700 K measurements.
§ Lxx = xx% lumen maintenance (when light output drops below xx% of initial output). All values are given at B10, or the median value where 90% of the LED population is better than the reported or calculated lumen maintenance measurement.
¶ Minimum surge limits per IEC 61547, tested in accordance with IEC 61000-4-5.
§§ Efficacy measurements are estimated based on the 305 mm (1 ft) measurements.
¶¶ Lumen maintenance figures are based on lifetime prediction graphs supplied by LED source manufacturers. Whenever possible, figures use measurements that comply with IES LM-80-08 testing procedures. In accordance with TM-21-11, Reported values represent the interpolated value based on six times the LM-80-08 total test duration (in hours). Calculated values represent time durations that exceed six times the total test duration.

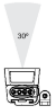
Dimensions



Photometrics High Power, 3500 K, 30° x 60° beam angle, 305 mm (1 ft)

Photometric data is based on full hemisphere testing to IES standards.

Beam Angle	30° x 60°
LED	All Channels On
Lumens	509.0
Efficacy (lm/W)	62



Illuminance at Distance

	Center Beam fc	Beam Width	
4 ft	35.5 fc	7.3 ft	1.9 ft
8 ft	8.9 fc	14.5 ft	3.8 ft
12 ft	3.9 fc	21.8 ft	5.7 ft
16 ft	2.2 fc	29.0 ft	7.6 ft
20 ft	1.4 fc	36.3 ft	9.5 ft
24 ft	1.0 fc	43.6 ft	11.5 ft

7.2 m (23.9 ft)
1 fc maximum distance

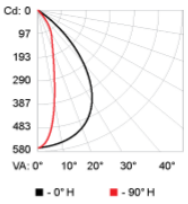
Vert. Spread: 84.4°
Horiz. Spread: 26.9°

Zonal Lumen

Zone	Lumens	% Luminaire
0-30	268.9	52.8%
0-40	376.7	74.0%
0-60	489.3	96.1%
60-90	18.7	3.7%
70-100	5.3	1.0%
90-120	0.1	0.0%
0-90	508.0	99.8%
90-180	1.0	0.2%
0-180	509.0	100.0%

For lux multiply fc by 10.7

Polar Candela Distribution



	0	25	45	70	90
0	568	568	568	568	568
5	560	551	537	523	521
15	533	459	352	266	250
25	481	333	191	141	135
35	367	216	118	87	84
45	186	115	67	46	43
55	53	42	29	22	21
65	12	12	11	10	10
75	4	4	3	4	4
85	1	0	0	0	0
90	0	0	0	0	0

Coefficents of Utilization – Zonal Cavity Method

Effective Floor Cavity Reflectance: 20%

RCC %:	80				70				50				30				10				0
RW %:	70	50	30	0	70	50	30	0	50	30	20		50	30	20		50	30	20		0
RCR:																					
0	1.19	1.19	1.19	1.19	1.16	1.16	1.16	1.00	1.11	1.11	1.11		1.06	1.06	1.06		1.02	1.02	1.02		1.00
1	1.12	1.08	1.06	1.04	1.10	1.07	1.04	0.92	1.05	1.01	0.99		0.99	0.97	0.96		0.95	0.94	0.93		0.91
2	1.05	1.00	0.95	0.91	1.03	0.98	0.94	0.83	0.95	0.91	0.88		0.91	0.89	0.86		0.89	0.86	0.84		0.82
3	0.98	0.91	0.85	0.81	0.97	0.90	0.84	0.76	0.87	0.83	0.79		0.85	0.81	0.77		0.82	0.79	0.76		0.74
4	0.93	0.84	0.77	0.72	0.91	0.83	0.77	0.69	0.80	0.75	0.71		0.78	0.74	0.70		0.76	0.73	0.69		0.68
5	0.87	0.77	0.71	0.66	0.85	0.76	0.70	0.63	0.74	0.69	0.65		0.73	0.68	0.64		0.71	0.67	0.63		0.62
6	0.82	0.72	0.65	0.60	0.80	0.71	0.64	0.58	0.69	0.63	0.59		0.68	0.63	0.59		0.66	0.62	0.58		0.57
7	0.77	0.67	0.60	0.55	0.76	0.66	0.59	0.54	0.65	0.59	0.54		0.63	0.58	0.54		0.62	0.57	0.54		0.52
8	0.73	0.62	0.56	0.51	0.72	0.62	0.55	0.50	0.60	0.54	0.50		0.59	0.54	0.50		0.58	0.53	0.50		0.48
9	0.68	0.58	0.52	0.47	0.68	0.58	0.51	0.46	0.57	0.51	0.47		0.56	0.50	0.47		0.55	0.50	0.46		0.45
10	0.66	0.55	0.48	0.44	0.64	0.54	0.48	0.43	0.53	0.48	0.44		0.52	0.47	0.43		0.52	0.47	0.43		0.42

Luminaire and Accessories

Use Item Number when ordering in North America

Luminaire	Item Number	Item 12NC
Graze Compact Powercore gen2, IntelliHue, High Power, 30° x 60°, 305 mm (1 ft) Includes Luminaire, Hinge(s), and Tether Anchor.	423-000034-18	912400137841
Accessories		
Graze Compact Powercore Jumper Cable, 1 ft, CE/CQC	108-000073-01	912400136931
Graze Compact Powercore Jumper Cable, 5 ft, CE/CQC	108-000073-03	912400136933
Graze Compact Powercore Jumper Cable, 1 ft, UL	108-000073-00	912400136930
Graze Compact Powercore Jumper Cable, 5 ft, UL	108-000073-02	912400136932
Graze Compact Powercore Leader Cable, 10 ft, CE/CQC	108-000074-01	912400136941
Graze Compact Powercore Leader Cable, 10 ft, UL	108-000074-00	912400136940
Graze Compact Constant Torque Hinge, (Set of 10)	120-000211-00	912400136664
Graze Compact Masking Tray, 305 mm, 1 ft	120-000209-00	912400136656
Graze Compact Masking Tray End Plate, (Pair)	120-000209-04	912400137116
Architectural Mounting Arm, Short, Gray	120-000206-00	912400136642
Architectural Mounting Arm, Medium, Gray	120-000206-01	912400136643
Architectural Mounting Arm, Long, Gray	120-000206-02	912400136644
Graze Compact Symmetric Louver, 305 mm, 1 ft	120-000207-00	912400136648
Graze Compact Tether Anchor, (Set of 10)	120-000211-01	912400136665
Graze Compact Masking Shield, 305 mm, 1 ft	120-000216-01	912400137226
Power Supplies		
Data Enabler Pro, 3/4 in / 1/2 in NPT (U.S. trade size conduit)	106-000004-00	910503701210
Data Enabler Pro, PG21/PG13 (metric size conduit)	106-000004-01	910503701211

COLORKINETICS

© 2024 Signify Holding. All rights reserved. Specifications are subject to change without notice. No representation or warranty as to the accuracy or completeness of the information included herein is given and any liability for any action in reliance thereon is disclaimed.

08/06/2024

Color Kinetics
www.colorkinetics.com/global/products/intellihue/graze-compact-powercore-gen2

EQUIPMENT	
MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	CLX L48 10000LM SEF FDL MVOLT EZ1 30K 80 CRI MB
TOTAL WATTS	35
VOLTAGE	120-277VAC
MOUNTING	Surface
WEIGHT	7.5 lb
DIMENSIONS	48.47" x 3.44" x 2.72"
FINISH	Matte black
RATING	IP
LISTING	BAA
SOURCE	
MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	10,000
ANTICIPATED LIFE	100,000
POWER SUPPLY	
TYPE	Integral
PROVIDED BY	
ACCESSORIES	

Surface mount fixed with one (1) LED lighting source, 10,000 delivered lumens, 3000K color engine, 80+ CRI, flat optic and integral driver. should operate on 120-277VAC voltage and be supplied with a 0-10v control option down to 1% and include a minimum 5-year warranty with a 100,000 hour anticipated life. To have matte black finish. should be CSA listed or an approved equivalent.

CONTROL	
PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

RRL - RELOC®-Ready Luminaire

- RRL connectors can be used with Quick-Flex®, System 820 and OnePass® systems.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example:** RRLA

Series		Wiring instructions	
RRL	RELOC®-ready luminaire	A	Hot conductor wired to position #1 (phase A)
		B	Hot conductor wired to position #2 (phase B)
		C	Hot conductor wired to position #3 (phase C) [1]

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)

OCS

OCU

OD

DC

PT

Notes

1 C, ABE, and C12S options are not used with Quick-Flex QFC, QSFC, QPT, and QD.

PLUG-IN WIRING INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Not for use with dedicated emergency circuits.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits		Dimming	Ground
			Circuits to which driver is connected	Battery charging circuit (must be unswitched)		
PLR	(blank)	Not required for PLR22	(blank) Not required for PLR22	(blank) No battery charging circuit	LV Low-voltage dimming	G Ground (required)
PLR22	1	Black	A Black wire	ELA Battery pack wired to black wire		
	2	Black and red	B Red wire	ELB Battery pack wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit PLR22
- Multiple circuit with night-lights located along row as desired

© 2018-2023 Acuity Brands Lighting, Inc. All rights reserved.

EQUIPMENT

MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	CLX L48 3000LM SEF FDL MVOLT GZ10 30K 80 CRI MB
TOTAL WATTS	26.7
VOLTAGE	120-277
MOUNTING	Surface
WEIGHT	7.5 lb
DIMENSIONS	48.47" x 3.44" x 2.72"
FINISH	Matte black
RATING	IP
LISTING	BAA

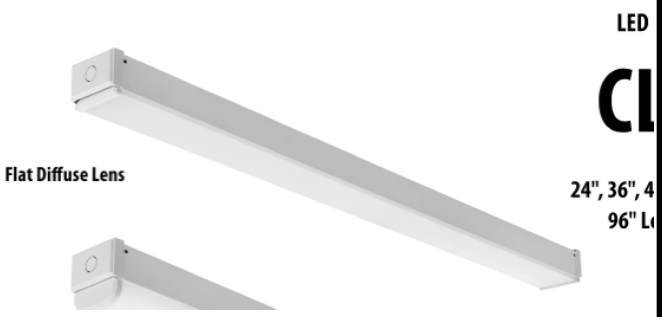
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	3000
ANTICIPATED LIFE	100,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Surface mount fixed linear with one (1) LED lighting source, 3000 delivered lumens, 3000K color engine, 80+ CRI and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option down to 10% and include a minimum 5-year warranty with a 100,000 hour anticipated life. Linear to have matte black finish. Linear should be CSA listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	DIMMING

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

L82

Catalog Number	CLX L48 3000LM SEF FDL MVOLT GZ10 30K 80 CRI MB
Notes	
Type	

LITHONIA LIGHTING®

LED Linear

CLX

24", 36", 48" and 96" Lengths

FEATURES & SPECIFICATIONS

INTENDED USE — The CLX is a linear lighting solution that is available in multiple lengths, lumen packages and distributions. Designed for versatility, the CLX can address virtually any indoor lighting need. The CLX is also offered in standard and high efficacy configurations and capable of being continuous row mounted or installed as a stand-alone fixture. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Channel and cover are formed from code-gauge cold-rolled steel. Housing and lens endcaps are injection molded plastic to provide a more architectural look and feel. The endcaps come standard with a 7/8" knock out for continuous mounting but can be ordered without.

Finish: Paint options include high-gloss, baked white polyester (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Offered with acrylic lens and less lens configurations. Provides a choice of optical distributions including, wide, narrow, and aisle.

Models with wide diffuse lens provide up to 12% uplight. Please check the IES file for specific uplight value.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 9.) Electronic LED driver is multi-volt input and 0-10V dimming standard (see Operational Data on page 6 for actual wattage consumption). This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided. Color Variation within 3-step MacAdam ellipse (3SDCM).

L70>100,000 hours at 25°C.

LEDs provide nominal 80 CRI or 90 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,500 lumens per foot.

INSTALLATION — Fixture may be ceiling or wall mounted (with or without THCLX hanger or angle mounted with CLXANGBKT), pendant or stem mounted with appropriate mounting options.

WARNING — Removing the lens and opening the fixture during installation exposes the LEDs, putting them at risk for damage.

If you plan to surface mount the fixture, we recommend using the THCLX. This eliminates the need to open the fixture.

If you plan to continuous row mount, we recommend using the PLR wiring harness option. This eliminates the need to open the fixture.

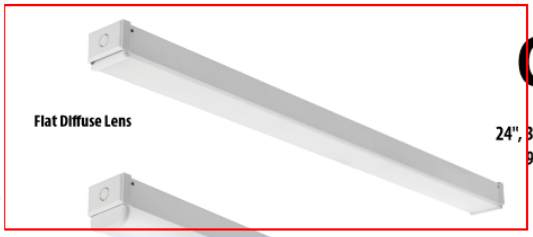
Damage to the LEDs caused during installation will not be covered under the warranty.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 104°F (40°C). Optional High Ambient (HA) ranging to 122°F(50°C) available on certain lumen packages (See ambient temperature chart for additional information).
DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

GOVERNMENT PROCUREMENT — BAA – Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product with the BAA option also qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.



Flat Diffuse Lens

Round Diffuse Lens

Wide Diffuse Lens

CLX with Reflector

Stock configurations are offered for shorter lead times:

Stock Part Number	UPC
CLX L48 3000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525816
CLX L48 3000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525885
CLX L48 5000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525939
CLX L48 5000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525908
CLX L96 6000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525861
CLX L96 6000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525915
CLX L96 10000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525922
CLX L96 10000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525830
CLX L48 3000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525960
CLX L48 3000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525892
CLX L48 5000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525854
CLX L48 5000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525946
CLX L96 6000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525878
CLX L96 6000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525823
CLX L96 10000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525953
CLX L96 10000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525847

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.
All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specifications for chromatic consistency – including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing visit www.acuitybrands.com/aplus.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

CLX LED Linear

Design Select options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: CLX L48 5000LM SEF WDL MVOLT GZ10 40K 80CRI WH

Series	Length	Nominal lumens	Performance package	Louver	Lens
CLX LED linear	L24 24"	1500LM 1,500 lumens 2000LM 2,000 lumens 2500LM 2,500 lumens 3500LM 3,500 lumens 4500LM 4,500 lumens 5000LM 5,000 lumens	SEF Standard efficiency ‡ HEF Premium efficiency ‡	(Blank) Less louver SBLW Straight blade louver, white ‡ SBLMB Straight blade louver, matte black ‡ SBLGV Straight blade louver, galvanized ‡ SBLSKGY Straight blade louver, smoke gray ‡	L/Lens Less lens FDL Flat diffuse ‡ RDL Round diffuse ‡ WDL Wide diffuse ‡
	L36 36"	2250LM 2,250 lumens 3000LM 3,000 lumens 3750LM 3,750 lumens 5250LM 5,250 lumens 6750LM 6,750 lumens 7500LM 7,500 lumens			
	L48 48"	3000LM 3,000 lumens 4000LM 4,000 lumens 5000LM 5,000 lumens 7000LM 7,000 lumens 9000LM 9,000 lumens 10000LM 10,000 lumens			
	L96 96"	6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens 14000LM 14,000 lumens 18000LM 18,000 lumens 20000LM 20,000 lumens			

Distribution	Voltage		Driver ‡	Glare Reflector	Color temperature	Coloring rendering index
(Blank) General ND Narrow ‡ WD Wide ‡ AD2 Aisle, 24' off center ‡	MVOLT 120-277V ‡ 120 120V 208 208V ‡ 240 240V ‡	277 277V 347 347V ‡ 480 480V ‡	GZ1 Generic 0-10V, dims to 1% ‡ GZ10 Generic 0-10V, dims to 10% ‡ EZ1 eldoLED 0-10V, dims to 1% ‡	(blank) No reflectors LUGR Reflectors for additional glare reduction ‡	30K 3000 K 35K 3500 K 40K 4000 K 50K 5000 K	80CRI 80 CRI 90CRI 90 CRI

Options

E10W	10W Emergency battery pack, constant power, Certified in CA Title 20 MAEDBS, User selectable Self-Diagnostic, AC Activate with Integral Test Switch [LINK] ‡
E10WSTAR	Emergency battery pack, Enabled with STAR ‡
BGTD	Generator transfer device, not available with E10W ‡
OCS	5', 18/3 Reloc selectable One Pass cable (fixture will bear dry location label) ‡
HA	High ambient, for use in ambient temperatures up to 50°C ‡
EPNKO	Decorative endplate, no knock out ‡
OUTCTR	Wiring leads pulled through back center of fixture ‡
OUTEND	Wiring leads pulled through end of fixture ‡
Cord Sets: ‡	
CS1W	6' Staight blade plug, 120V ‡
CS3W	NEMA twist-lock plug, 120V ‡
CS7W	Staight blade plug, 277V ‡
CS11W	NEMA twist-lock plug, 277V ‡
CS25W	NEMA twist-lock plug, 347V ‡
CS97W	NEMA twist-lock plug, 480V ‡
CS93W	600V SEOOW white cord, no plug (no voltage required) ‡
CS6WG16STOWDSD	6' white cord, 16/5, no plug, includes low voltage dimming wires (no voltage required) ‡
PLR___	Plug-in wiring, see page 9 for ordering information
PLR1G	Plug-in wiring, single circuit, Ground
PLR1LVG	Plug-in wiring, single circuit, low-voltage dimming, Ground ‡
RRL___	RELOC®-ready luminaire. See page 10 for ordering information
SPD	Surge protection device, provides up to 6kV protection ‡
BAA	Buy America(n) Act and/or Build America Buy America Qualified
nLight® Wireless:	
NLTAIR2 RES7	nLight AIR Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell ‡
NLTAIR2 RES7EM	nLight AIR Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell and UL924 Emergency operation, via power interrupt detection ‡
NLTAIR2 RES7PDT	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell ‡
NLTAIR2 RES7PDTEM	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell and UL924 Emergency operation, via power interrupt detection ‡
NLTAIR2 RIO	No sensor control ‡
NLTAIR2 RIOEM	No sensor, Control Input function only and UL924 Emergency operation, via power interrupt detection ‡
nLight® Wired:	
N100	nLight® without lumen management
N100EMG	nLight® without lumen management For use with generator supply EM power ‡
NES7	nLight® nES 7 PIR integral occupancy sensor ‡
NESPDT7	nLight® nES PDT 7 dual technology integral occupancy control ‡
NES7ADCX	nLight® nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell ‡
NESPDT7ADCX	nLight® nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell ‡
Individual controls: ‡	
MSD7	PIR integral occupancy sensor
MSDPDT7	PDT 7 dual technology integral occupancy control
MSD7ADC	PIR integral occupancy sensor with automatic dimming control photocell
MSDPDT7ADC	PDT integral occupancy sensor with automatic dimming control photocell

Finish

WH	White
GALVW	Galvanized with white lens end caps
GALVB	Galvanized with black lens end caps
MB	Matte black
SKGYW	Smoke gray with white lens end caps
SKGYB	Smoke gray with black lens end caps

See Accessories and footnotes on next page

COMMERCIAL INDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@AcuityBrands.com www.lithonia.com

© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

Accessories: *Order as separate catalog number.*

Mounting:

ZACVH M100	Adjustable 10' aircraft cable with Y hanger (1 pair)
ZAC120	One adjustable aircraft cable with canopy 120", white
ZACFP120	One adjustable aircraft cable with feed (3 conductor) and canopy, 120", white
ZACFPD120	One adjustable aircraft cable with feed (5 conductor) and canopy 120", white
ZAC240	One adjustable aircraft cable with canopy 240", white
ZACFP240	One adjustable aircraft cable with feed (3 conductor) and canopy, 240", white
ZACFPD240	One adjustable aircraft cable with feed (5 conductor) and canopy 240", white
SQ_	Swivel stem hanger (specify length in 2" increments up to 48") Ships White ‡
THCLX ___	Tong hanger (Must specify color) (one pair) ‡
CLXANGBKT ____	Angle bracket, (Must specify color) (one pair) ‡
HC36 M12	Hanger chain, 36" (1 pair)

Wireguards:

WGCLX24 ___	24" wireguard qty 1, (Must specify color) ‡
WGCLX36 ___	36" wireguard qty 1, (Must specify color) ‡
WGCLX48 ___	48" wireguard qty 1, (Must specify color) ‡
WGCLX48 ___ J2	48" wireguard qty 2, (Must specify color) ‡
WGCLX48 ___ J25	48" wireguard qty 25, (Must specify color) ‡
WGCLX48 ___ J50	48" wireguard qty 50, (Must specify color) ‡

‡ Option Value Ordering Restrictions

Option value	Restriction
347V, 480V	Voltage selected utilizes a step-down transformer. Not available with L24 when ordered with N100. Not available with E10W or BGTD options.
BGTD	Not available with MVOLT, 208V or 240V. Not available with HA. Available with L48 or L96 only. Not available with E10W option. Not available with 208 or 240V. Not available Individual controls, NLight Wired, or NLight Wireless options.
CS1W, CS3W, CS7W, CS11W, CS25W, CS963W, CS97W	Not available with BGTD option. Must specify voltage. Not available with PLR options.
CS6WG16STOWD5D	Not available with Individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options. Not available with PLR options.
Driver	When continuous row mounting, fixtures must all have the same driver selection.
E10W	Not available with HA. Not available with 347V or 480V. Not available with BGTD option. Requires SPD option. Not available with L24 or L36. Not available with L48 in combination with N100.
E10WSTAR	Not available with HA. Not available with 347V or 480V. Not available with BGTD option. Requires SPD option. Not available with L24 or L36. Not available with L48 in combination with N100.
EPNKO	Not available OUTEND.
EZ1	Not available with HA option. Not available with 5000LM, 7500LM.
FDL, RDL, WDL	Only available with general distribution. Not available with CLXRN accessories.
GZ1, GZ10	Not available with Individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options.
HA	Not available with L24, L26. Not available with BGTD option. Not available with EZ1. Only available with L48 3000/4000/5000LM and L96 6000/8000/10000LM.
HEF	Not available with L48 3000LM and L96 6000LM
LUGR	Not available with L36 length. Only available with WH finish. Not compatible with THCLX Hanger or wireguard accessories. LUGR option required for some DLC premium qualifications - Please check the DLC Qualified Products List to determine if LUGR option is necessary to meet requirement. If mounting in continuous rows, ensure all models ordered with LUGR option if required on any configuration to ensure rows match in form factor. LUGR reflectors ship in standard fixture carton and are not sold as separate accessory - this option MUST be specified as part of the CLX model number.
MSD7, MSDPDT7, MSD7ADC, MSDPDT7ADC	Not available with any other control option. Requires EZ1. Sensor housing will be the same color as lens end caps.
N100, N100EMG	nLight EMG option requires a connection to existing nLight network. Power is provided from separate N100 enabled fixture.
ND, WD, AD2	Not available with CLXRN accessories. Available L/LENS only.
NES7, NESPDT7, NES7ADCX, NESPDT7ADCX	Not available with any other control option. Requires EZ1. Requires N100 or N100EMG option, N100EMG with NES7 requires RFA. Sensor housing will be the same color as lens end caps.
NLTAIR2 RES7(EM), NLTAIR2 RES7PDT(EM), NLTAIR2 RIO(EM)	Sensor housing will be the same color as lens end caps. For EM, see UL924 Sequence of Operation chart below.
OCS	Must specify voltage.
OUTCR	Not available with L24. Not available with PLR options.
OUTEND	Not available with PLR options.
PLR1LVG	Not available with Individual controls, NLight Wired, or NLight Wireless options. Refer to page 9 for more PLR details. Not available with cord set options.
SBLW, SBLMB, SBLGV, SBLSKGY	When ordered with L24 only available with 1500LM or 2000LM in combination with GZ10 driver. Not for use with THCLX, CLXANGBKT or WGCLX accessories. Not available with RDL lens options.
SEF	Not available with EZ1 when ordered with L24 with 5000LM or L36 with 7500LM.
SPD	Required with E10W, BGTD.
THCLX ___, CLXANGBKT ____	Not available with louver or wireguards. THCLX___ not available with LUGR.
Wireguards	Not for use with LUGR option. For L96 fixtures, use qty 2 48" wireguards.
SQ	No available with L24 or L36

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

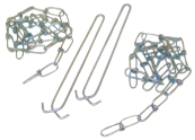
© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

OPTIONS AND ACCESSORIES

Wireguard
Ships separately from fixture:
96" fixture requires two WGCLX48.
Order as:
WGCLX24__
WGCLX36__
WGCLX48__

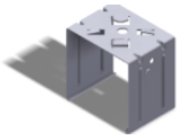
LUGR glare reflector
NOT available as accessory - must be specified as part of the fixture nomenclature. See ordering notes on page 3.

Aircraft Cable with Canopy
Available in 120" or 240"
Order as:
ZAC120
ZAC240



HANGER CHAIN
36" chain with Y hanger. ships as a pair
Order as:
HC36

ZACVH HANGER
10' Aircraft cable with Y hanger.
Order as:
ZACVH



Tong hanger
Ships as a pair
Order As:
THCLX__

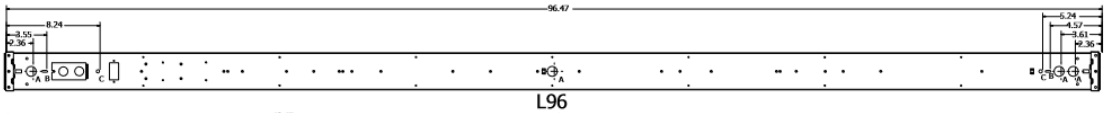
© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

DIMENSIONS

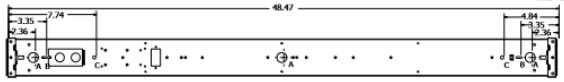
All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

INTEGRATED SENSOR ADDS 2.0 INCHES TO STANDALONE FIXTURE LENGTH
HOUSING END CAP ADDS 0.236 INCHES TO FIXTURE LENGTH PER SIDE. DIMENSIONS BELOW INCLUDE ENDCAPS.

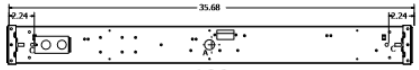
A - 7/8" KNOCK OUT
B - 0.5" by 0.16" SLOT
C - 0.3" DIA HOLE



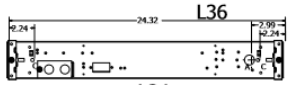
L96



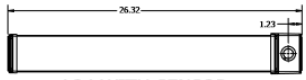
L48



L36



L24

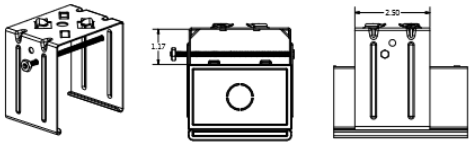


L24 WITH SENSOR

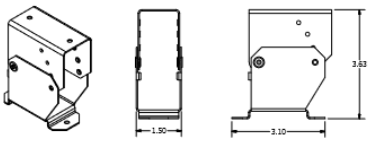
PALLET DIMENSIONS

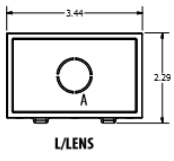
Length	Approx Weight	Fixtures per pallet	Pallet Dims (L X W X H)
L24	4 lb	100	54x46x37
L36	5 lb	80	54x46x37
L48	7.5 lb	64	54x46x37
L96	14 lb	64	98x46x37

THCLX - SHIPS TWO PER ORDER,
UTILIZES A #8 HEX HEAD SCREW AND NUT
FIXTURE SITS 1.3 INCHES FROM STRUCTURE WHEN MOUNTED

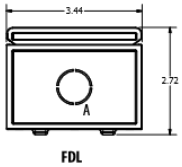


CLXANGBKT - SHIPS TWO PER ORDER
HOLES TO MOUNTING STRUCTURE ARE 0.175" DIA, 2.5" APART
FIXTURE SITS APPROXIMATELY 3.5" FROM STRUCTURE
WHEN MOUNTED HORIZONTAL TO STRUCTURE

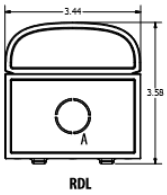




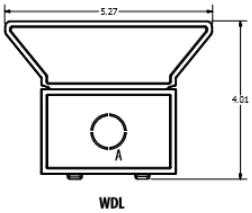
L/LENS



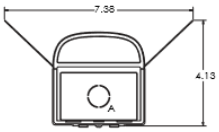
FDL



RDL



WDL



LUGR Reflector Option
- applies to all lens types

PHOTOMETRICS

See www.lithonia.com.

© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

POWER SENTRY EMERGENCY BATTERY PACKS

		SEF Emergency Lumens	HEF Emergency Lumens
E10W	Factory installable	1400	1500
PS1555LCP	Field installable, remote mount only	2000	2100

Note: For emergency lumen output of specific model, please consult factory. One board will be illuminated during emergency operation.

Emergency Battery Pack Options - Field Installable

Battery Model Number	Wattage	Runtime (Minutes)	Lumen Output* @ 120 Lumens/Watt	Other
ILB CP07 2H A	7W	120	840	Storm Shelter / 2 Hour Runtime
ILB CP10 A	10W	90	1200	
ILBLP CP10 HE SD A	10W	90	1200	Title 20, Self Diagnostic
ILB CP10 HE AELR A	10W	90	1200	Title 20; Enabled with Self Testing, Automated Reporting (STAR)
ILBLP CP15 HE SD A	15W	90	1800	Title 20, Self Diagnostic
ILB CP20 HE A	20W	90	2400	Title 20
ILB CP20 HE SD A	20W	90	2400	Title 20, Self Diagnostic

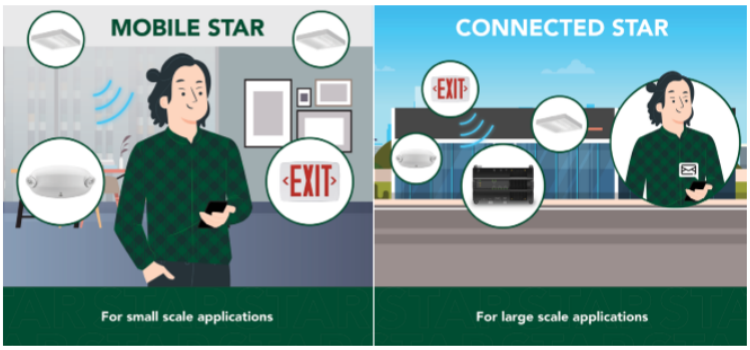
All the above are UL Listed products that are certified for field install external/remote to the fixture.
*Minimum delivered lumen output to assist in product selection for increased fixture mounting height.
The CP10 delivered emergency illumination outperforms legacy 1400 lumen fluorescent emergency ballast.
Please contact us at techsupport@iotaengineering.com for any Emergency Battery related questions.

Enabled with STAR

Emergency Lighting with Self-Testing Automated Reporting (STAR), enables self-testing and automated reporting to aid in life safety code compliance. Build your solution and choose your preferred deployment from Mobile STAR, where test data is logged in each individual unit and broadcast to the CIAIRity™+ app, or Connected STAR, where test data is logged in the STAR Gateway by IOTA® and emailed directly. **Leave the ladders, disruptions and written records behind with emergency lighting solutions with STAR!**

Life Safety Code NFPA 101 testing and reporting requirements for emergency lighting include:

- Testing for 30 seconds every 30 days
- Testing for 90 minutes once a year
- Record keeping and to report to the authority having local jurisdiction



© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

CLX CHARACTERISTICS

Nominal Lumen Package	Length	Wattage								Length	Width	Depth	Comparable Light Source
		Standard Efficiency				High Efficiency							
		120V	277V	347V	480V	120V	277V	347V	480V	Dimensions are shown in inches			
2500LM	24"	18.4	18.4	24.0	24.0	17.4	17.4	23.1	23.1	24	3.5	3.75	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
5000LM	24"	41.5	41.5	47.4	47.4	38.1	38.1	44.1	44.1	24	3.5	3.75	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
3750LM	36"	26.5	26.5	32.1	32.1	25.1	25.1	30.7	30.7	36	3.5	3.75	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
7500LM	36"	62.6	62.6	68.6	68.6	54.0	54.0	59.7	59.7	36	3.5	3.75	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
5000LM	48"	31.8	31.8	37.2	37.2	30.3	30.3	35.8	35.8	48	3.5	3.75	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
10000LM	48"	70.7	70.7	76.2	76.2	65.3	65.3	70.8	70.8	48	3.5	3.75	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
10000LM	96"	63.7	63.7	69.0	69.0	60.6	60.6	66.1	66.1	96	3.5	3.75	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
20000LM	96"	141.3	141.3	146.8	146.8	130.5	130.5	136.1	136.1	96	3.5	3.75	6-lamp 32W T8, 4-lamp 54W T5HO, 200W HID

Note: For wattage by configuration, please reference the CLX Operational Data Document.

Lumen Package	UGR Values of CLX L24 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)													
	FDL		RDL		WDL		FDL LUGR		RDL LUGR		WDL LUGR		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
1500LM SEF	21.2	23.8	19.4	25.2	17.4	21.1	16.8	14	17.8	16.6	18.1	17.9	24.9	25.1
2000LM SEF	22.3	24.9	20.5	26.3	18.6	22.3	17.9	15.1	18.8	17.6	19.2	18.9	26.1	26.2
2500LM SEF	23.1	25.7	21.3	27.1	19.4	23.1	18.6	15.8	19.6	18.4	19.9	19.7	26.9	27
3500LM SEF	24.1	26.7	22.3	28.1	20.4	24.1	19.7	16.9	20.7	19.5	21	20.8	27.9	28.1
4500LM SEF	25.4	28	23.6	29.4	21.7	25.4	20.7	17.9	21.7	20.5	22	21.8	29.2	29.3
5000LM SEF	25.6	28.2	23.3	29.1	21.4	25.1	21	18.3	21.5	20.3	21.8	21.5	29.4	29.5
1500LM HEF	21.1	23.7	19.3	25.1	21.8	25.5	16.5	13.7	17.6	16.3	17.8	17.6	24.9	25
2000LM HEF	22.2	24.8	20.4	26.2	17.4	21.1	17.6	14.8	18.6	17.4	18.8	18.6	26	26.2
2500LM HEF	23	25.7	21.3	27	18.5	22.2	18.4	15.6	19.4	18.2	19.7	19.4	26.8	27
3500LM HEF	24.1	26.7	22.3	28.1	19.3	23	19.8	17	20.9	19.7	21.1	20.9	27.9	28
4500LM HEF	25.3	27.9	23.5	29.3	20.4	24.1	20.8	18	21.8	20.6	22.1	21.8	29.1	29.3
5000LM HEF	25.5	28.1	23.7	29.5	21.6	25.3	21.1	18.3	22.1	20.9	22.3	22.1	29.3	29.5

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

Lumen Package	UGR Values of CLX L36 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)							
	FDL		RDL		WDL		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
2250LM SEF	21.4	24.1	19.7	25.6	17.7	21.6	25.2	25.4
3000LM SEF	22.3	25	20.6	26.5	18.6	22.5	26.2	26.3
3750LM SEF	23.2	25.9	21.4	27.3	19.5	23.4	27	27.2
5250LM SEF	24.2	26.9	22.5	28.4	20.5	24.4	28	28.2
6750LM SEF	25.1	27.8	23.3	29.2	21.4	25.3	28.9	29
7500LM SEF	25.4	28.1	23.6	29.5	21.7	25.6	29.2	29.4
2250LM HEF	25	27.7	20.5	26.4	18.6	22.5	25.2	25.3
3000LM HEF	25.3	28	21.4	27.3	19.4	23.3	26.1	26.2
3750LM HEF	21.4	24.1	22.4	28.3	20.5	24.4	27	27.1
5250LM HEF	22.3	25	23.2	29.2	21.3	25.2	28	28.1
6750LM HEF	23.1	25.8	23.6	29.5	21.6	25.5	28.8	29
7500LM HEF	24.2	26.8	19.6	25.5	17.7	21.6	29.1	29.3

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values.
To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

COMMERCIAL INDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@AcuityBrands.com www.lithonia.com

© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

Lumen Package	UGR Values of CLX L48 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)													
	FDL		RDL		WDL		FDL LUGR		RDL LUGR		WDL LUGR		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
3000LM SEF	21.8	24.5	19.7	25.3	18.6	23.4	19.2	16.5	20.2	19	20.6	20.3	24.8	25.6
4000LM SEF	22.8	25.5	20.7	26.3	19.6	24.4	20.3	17.5	21.2	20	21.6	21.4	25.8	26.6
5000LM SEF	23.6	26.3	21.4	27	20.4	25.2	21	18.2	21.9	20.7	22.3	22.1	26.6	27.3
7000LM SEF	24.8	27.6	22.7	28.3	21.6	26.5	22.3	19.6	23.3	22.1	23.7	23.4	27.8	28.6
9000LM SEF	25.6	28.4	23.5	29.1	22.5	27.3	23.2	20.4	24.1	22.9	24.5	24.3	28.6	29.4
10000LM SEF	26	28.7	23.8	29.5	22.8	27.6	23.6	20.8	24.5	23.3	24.9	24.7	29	29.8
3000LM HEF	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4000LM HEF	22.8	25.6	20.7	26.3	22.8	25.6	20.3	17.5	21.3	20.1	21.7	21.4	29.5	30.3
5000LM HEF	23.6	26.3	21.4	27	23.6	26.3	21	18.2	21.9	20.7	22.3	22.1	30.2	31
7000LM HEF	24.8	27.6	22.7	28.3	24.8	27.6	22.4	19.6	23.4	22.2	23.8	23.5	27.8	28.6
9000LM HEF	25.7	28.4	23.6	29.2	25.7	28.4	23.2	20.4	24.2	23	24.6	24.3	28.7	29.5
10000LM HEF	26	28.7	23.9	29.5	26	28.7	23.6	20.9	24.6	23.4	25	24.7	29	29.8

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

Lumen Package	UGR Values of CLX L96 @ 80CRI and 3500K UGR (70% 50% 20% reflectance using a 4H x 8H room size)													
	FDL		RDL		WDL		FDL LUGR		RDL LUGR		WDL LUGR		L/LENS	
	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise	Crosswise	Endwise
6000LM SEF	21.8	24.6	19.7	25.4	17.9	22.4	19.3	16.5	20.2	19	20.6	20.4	24.8	25.6
8000LM SEF	22.8	25.5	20.7	26.4	18.8	23.4	20.3	17.6	21.2	20.1	21.6	21.4	25.8	26.6
10000LM SEF	23.6	26.3	21.4	27.2	19.6	24.2	21	18.3	21.9	20.8	22.3	22.1	26.5	27.3
14000LM SEF	24.8	27.6	22.7	28.5	20.9	25.5	22.4	19.6	23.3	22.1	23.7	23.5	27.8	28.6
18000LM SEF	25.7	28.4	23.5	29.3	21.7	26.3	23.2	20.5	24.1	23	24.5	24.3	28.6	29.4
20000LM SEF	26	28.7	23.9	29.6	22	26.6	23.6	20.9	24.5	23.4	24.9	24.7	29	29.7
6000LM HEF	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8000LM HEF	22.8	25.6	20.7	26.5	18.9	23.5	20.4	17.6	21.3	20.1	21.7	21.5	25.8	26.6
10000LM HEF	23.6	26.3	21.4	27.2	19.6	24.2	21	18.3	21.9	20.8	22.3	22.1	27	27.8
14000LM HEF	24.9	27.6	22.7	28.5	20.9	25.5	22.4	19.7	23.4	22.2	23.8	23.5	27.8	28.6
18000LM HEF	25.7	28.4	23.6	29.3	21.7	26.3	23.2	20.5	24.2	23	24.6	24.3	28.7	29.5
20000LM HEF	26	28.8	23.9	29.6	22.1	26.6	23.7	20.9	24.6	23.4	25	24.8	29	29.8

UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application

© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

AMBIENT TEMPERATURE RATINGS

Driver Package		GZ10			EZ1 or EOHN			Any Driver	
Length	Lumen package	Direct Surface	THCLX/ Suspended	HA Option (Direct or Suspended)	Direct Surface	THCLX	Suspended 18"	Xpoint/ BGTD Direct Surface	E10W Suspended
L24	1500LM	40C	40C	N/A	35C	35C	35C	N/A	N/A
	2000LM	40C	40C		35C	35C	35C		
	2500LM	40C	40C		35C	35C	35C		
	3000LM	40C	40C		40C	40C	40C		
	4500LM	40C	40C		35C	35C	40C		
	5000LM	40C	40C		25C	30C	35C		
L36	2250LM	40C	40C		40C	40C	40C		
	3000LM	40C	40C		40C	40C	40C		
	3750LM	40C	40C		40C	40C	40C		
	5250LM	40C	40C		35C	35C	40C		
	6750LM	30C	40C		35C	35C	40C		
	7500LM	30C	40C		25C	30C	35C		
L48	3000LM	40C	40C	50C	40C	40C	40C	35C	25C
	4000LM	40C	40C	50C	40C	40C	40C		
	5000LM	40C	40C	50C	35C	35C	40C		
	7000LM	30C	40C	N/A	35C	35C	40C		
	9000LM	30C	40C		25C	30C	35C		
	10000LM	30C	40C		25C	30C	35C		
L96	6000LM	40C	40C	50C	35C	35C	40C		
	8000LM	30C	40C	50C	35C	35C	40C		
	10000LM	30C	40C	50C	25C	30C	35C		
	14000LM	40C	40C	N/A	35C	35C	40C		
	18000LM	30C	40C		25C	30C	35C		
	20000LM	30C	40C		25C	30C	35C		

© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

RRL - RELOC®-Ready Luminaire

- RRL connectors can be used with Quick-Flex®, System 820 and OnePass® systems.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example:** RRLA

Series		Wiring instructions	
RRL	RELOC®-ready luminaire	A	Hot conductor wired to position #1 (phase A)
		B	Hot conductor wired to position #2 (phase B)
		C	Hot conductor wired to position #3 (phase C) [1]
		C12S	Ballast/driver wired to pin position #1 (120V, 277V, 347V - Phase A). Low voltage wire (positive/purple) (data1) wired to pin position #2. Low voltage wire (common/gray) (data2) wired to pin position #3 [2]

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)

OCS

OCU

OD

DC

PT

Notes

1 C, ABE, and C12S options are not used with Quick-Flex QFC, QSFC, QPT, and QD.

2 RRLC12S option is to be used with the OnePass OCU, OCS, OD, OFC and OD for 0-24V integrated single-circuit or 0-10V low voltage controls applications. Not available with integral dimming sensors.

PLUG-IN WIRING INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Not for use with dedicated emergency circuits.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits (PLR2A / PLR2B Only)		Dimming		Ground	
PLR22	(blank)	Not required for PLR22	(blank)	Not required for PLR22	(blank)	No Dimming	G	Ground (required)
PLR	1	Black	(blank)	Not required for PLR1	(blank)	No Dimming	G	Ground (required)
	2	Black and red	**Circuits to which driver is connected**	**Battery charging circuit (must be unswitched)**	LV	Low-voltage Dimming	G	Ground (required)
			(blank) Not required for PLR22	(blank) No battery charging circuit				
			A Black wire	ELA Battery pack wired to black wire				
			B Red wire	ELB Battery pack wired to red wire				

Typical Applications

Notes:

When specifying PLR1, you will not specify A or B as there is only a single hot wire which would be black in color.

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit PLR22
- Multiple circuit with night-lights located along row as desired

COMMERCIAL INDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@AcuityBrands.com www.lithonia.com

© 2018-2025 Acuity Brands Lighting, Inc. All rights reserved.

EQUIPMENT

MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	FEM-L48-6000LM-LPAFL-MD-MVOLT-GZ10 -30K-80CRI
TOTAL WATTS	37.8
VOLTAGE	120-277
MOUNTING	Surface
WEIGHT	11 lb
DIMENSIONS	48" x 4.2" x 6.8"
FINISH	White
RATING	IP67
LISTING	UL Wet Listed

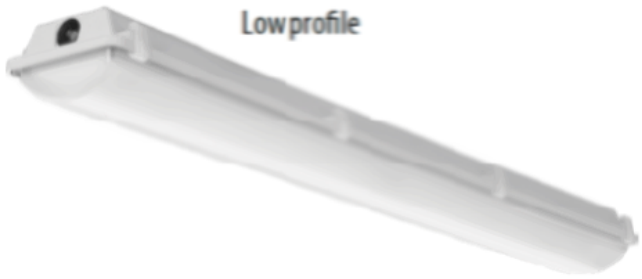
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	6000
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES



Surface mount fixed linear with one (1) LED lighting source, 6000 delivered lumens, 3000K color engine, 80+ CRI, 280° optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option down to 10% and include a minimum 5-year warranty. Linear to have white finish. Linear to be rated for IP67 or equivalent. Linear should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — A general purpose and energy-efficient surface-mounted or suspended LED fixture, suitable for wet, damp and/or cold locations. For vapor-tight demanding environments where moisture or dust is a concern and where relatively low fixture mounting heights and wide fixture spacing are common. Not for use or installation in direct outdoor sunlight. Must be installed under canopy or covered ceiling. For direct sunlight installations, please refer to the FEX product family. Typical applications include industrial facilities, parking garages, retail malls, multi-purpose rooms, garden centers, and food processing. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable use.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.

CONSTRUCTION — One-piece SVA fiberglass housing with integral perimeter channel utilizing continuous poured-in-place NEMA 4X gasket. Approved for through wiring. Captive polymeric latches are standard. Stainless steel latches (#316) available as an option for food processing or more demanding applications.

Power connection is easily accomplished through pre-drilled holes.

OPTICS — Injection molded, acrylic lens (.080" thick) provides high impact-resistance comparable to 100% DR. A UV stabilized polycarbonate diffuser is available (.080" thick) in clear or frosted for additional impact strength where vandal protection is desired.

Expected service life of 60,000 hours at 80% lumen maintenance (L80); predicted life of more than 100,000 hours.

ELECTRICAL — Utilizes high-efficiency LEDs mounted to core circuit boards. High-efficiency drivers operate 120-277 (MVOLT) and 347-480 (HVOLT) offered with 0-10 volt dimming, dims to 10%. Standard Luminaire Surge Protection Level: 6kV/3kA Surge Rated per ANSI C82.77-5-2015.

INSTALLATION — A pair of stainless steel surface mount brackets (SMB) are included (unless another mounting option is chosen) allowing for surface (ceiling) or suspension mount applications using included bail with aircraft cable or chain. Optional pair of dual pendant mount brackets (DPMB) are available for surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain. Optional pair of angle mounting brackets (ANGBKT) for wall mount applications.

LISTINGS — CSA Certified to UL and C-UL Standards. Suitable for wet location. IP65,IP66, IP67 rated. NSF Splash Zone 2 and Non-Food Zone rated. NEMA 4X rated. Sensors maintain IP65 and IP66 only. See chart on page 5 for Ambient Temperatures.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

BUY AMERICAN ACT — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Low-Profile Enclosed and Gasketed Industrial

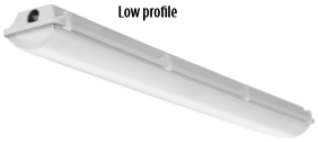
FEM LED

SURFACE/ SUSPENDED/WALL MOUNT

Deep Lens

Low profile with sensor

Low profile



Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number
FEM L48 4000LM LPAFL MD MVOLT GZ10 40K 80CRI	FEM L48 4L MVOLT
FEM L48 4000LM LPAFL MD MVOLT GZ10 50K 80CRI	FEM L48 4L MVOLT 5K

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

FEM LED Low-Profile Enclosed and Gasketed

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: FEM L48 4000LM IMAFL WD MVOLT GZ10 40K 80CRI

Series	Length	Nominal Lumens	Diffuser	Distribution	Voltage	Driver	Color temperature	CRI
FEM	L24 24" ‡	2000LM 2,000 lumens	IMAFL Acrylic, lineal ribbed frosted lens	MD Medium	MVOLT 120-277V	GZ10 0 - 10V dimming	30K 3000K	80CRI 80 CRI
		3000LM 3,000 lumens	IMACD Acrylic, clear deep lens	WD Wide	HVOLT 347-480V ‡		35K 3500K	90CRI 90 CRI
		4000LM 4,000 lumens	IMAFD Acrylic, deep frosted lens	PGD Parking garage	120 120V		40K 4000K	
		6000LM 6,000 lumens	LPAFL Acrylic, low profile frosted lens		277 277V		50K 5000K	
	L48 48" ‡	3000LM 3,000 lumens	LPACL Acrylic, low profile clear lens		347 347V			
		4000LM 4,000 lumens	LPPCL Polycarbonate, low profile clear lens		480 480V			
		6000LM 6,000 lumens	LPPFL Polycarbonate, low profile frosted lens					
		8000LM 8,000 lumens						
		10000LM 10,000 lumens						
		12000LM 12,000 lumens						
	L96 96" ‡	9000LM 9,000 lumens						
		12000LM 12,000 lumens						
		15000LM 15,000 lumens						
		18000LM 18,000 lumens						
		20000LM 20,000 lumens						
		24000LM 24,000 lumens						

Options

Emergency:

E10WMCP	EM Self-diagnostics battery pack, MVOLT, 10W, Constant Power Certified in the California Title 20 Modernized Appliance Efficiency Database (MAEDBS) ‡
BE6WCP	Cold Weather EM battery pack, 120/277V, 6W, Constant Power Certified in the California Title 20 Modernized Appliance Efficiency Database (MAEDBS) ‡
BGTD	Generator transfer device

Other Options:

ANGBKT	Angle bracket shipped with fixture ‡
BAA	Buy America(n) Act Compliant
DPMB	Dual pendant mounting bracket ‡
SPD	Surge protection device, additional 10kV/6kA
STSL	Stainless steel latches
TRS	Tamper Resistant Torx® T10 screws
WLF	Wet location fitting (two outboard, top (L24 - 20 inches off-center, L48 - 48 inches off-center, L96 - 95.7 inches off-center) ‡
WLFEND	Wet location fitting (one end) ‡
WLFEND2	Wet location fitting (both ends) ‡
WLFPMP	Wet location pendant monopoint ‡

Cord Sets: ‡

CPSB16YWLBH	Brad Harrsion Mini-Change® cordset with straight blade plug, 16 gauge, 3 conductors, 6ft, yellow ‡
CPSB16YWL12FTBH	Brad Harrsion Mini-Change® cordset with straight blade plug, 16 gauge, 3 conductors, 12ft, yellow ‡
CRSB16YWLBH	Brad Harrison Mini-Change® receptacle ‡
CNP16WWL	Cord only (no plug), 16 gauge, 3 conductors, white, 6ft, wet location ‡
CNP16WWL12FT	Cord only (no plug), 16 gauge, 3 conductors, white, 6ft, wet location ‡
CNP164CWWL	Cord only (no plug), 16 gauge, 4 conductors, white, 6ft, wet location (for use when unswitched circuit is required for battery pack) ‡

Individual Controls: ‡

SBOR10	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, ON/OFF occupancy (LINK) (formerly MSI10NWL)
SBOR10 HL 3V	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, occupancy controlled dimming (bi-level) (LINK) (formerly MSI102L3VWL)
SBOR10 P	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, ON/OFF photocell (LINK) (formerly MSI10NWL DSCNWL)

nLight Wireless: ‡

NLTAIR2 RSBOR10	nLight® Air Generation 2 enabled, 360° low mount sensor, (8-15' heights) (LINK)
NLTAIR2 RIO	nLight® Air Generation 2 enabled, fixture embedded network interface, 0-10V dimming output (LINK)

NOTE: ‡ indicates option chosen has ordering restrictions. Please reference ordering restrictions chart, page 3. Options are sorted alphanumerically.

Accessories: *Order as separate catalog number.*

MHCH 36	3 foot (36 inches) jack chain (pair)
MHHK120	10 foot (120 inches) single leg air craft cable (ships as pair)
MHHK120SS	10 foot (120 inches) single leg air craft cable, stainless steel (ships as pair)
RK1 T10BIT W/PIN U	Hex-base driver bit, Torx TX10, for tamper resistant screws with center reject pin
FEMDPMB	Dual pendant mounting bracket (ships as a pair) ‡
FEMANGBKT	Angle bracket (ships as pair) ‡
FEMSMB	Surface mount bracket (ships as pair) ‡

See Accessories and ordering restrictions on next page.

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

© 2012-2023 Acuity Brands Lighting, Inc. All rights reserved.

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
ANGBKT, FEMANGBKT	For wall mount applications. If mounted in an upward orientation, fixture will be damp location listed only.
BE6WCP	Utilizes Bodine BSL36 Cold-Pak emergency driver. Not available with L24 length. Order with CNP164CWWL when unswitched hot is required for battery. Not available with 347V,480V,HVOLT.
CNP16WWL, CNP16WWL12FT	Not available with BE6WCP or E10WMCP.
CNP164CWWL	Available with BE6WCP or E10WMCP only. **Not NEMA4X rated.**
Cord Sets	**Not NEMA4X rated.**
CPSB16YWLBH, CPSB16YWL12FTBH	Not available with BE6WCP or E10WMCP.
CRSB16YWLBH	Not available with BE6WCP or E10WMCP.
E10WMCP	Utilizes Power Sentry, PS1055MCP battery pack. Order with CNP164CWWL when unswitched hot is required for battery. Not available with 347V,480V,HVOLT.
DPMB, FEMDPMB	For surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain.
FEMSMB	Ships standard with fixture (unless another mounting option is chosen). For surface (ceiling) or suspension mount applications using included bail with aircraft cable or chain.
HVOLT	When ordered with L24, available with 6000LM only. When ordered with L48, not available with 3000LM or 4000LM.
Individual Controls	**Not NEMA4X rated. IP65 and IP66 rated.**
L24	Not available with BE6WCP.
L48	Not available with WLFPMP.
L96	Not available with WLFPMP
nLight® Wireless	**Not NEMA4X rated. IP65 and IP66 rated.**
WLF	If cord is ordered, cord will exit from the end of the fixture. **Not NEMA4X rated.**
WLFEND	If cord is ordered, cord will exit from the end of the fixture. **Not NEMA4X rated.** Available with cord or sensor option. Choose only one.
WLFEND2	Not available with sensor or cord options. **Not NEMA4X rated.**
WLFPMP	Available only with L24. **Not NEMA4X rated.**

MOUNTING OPTIONS

DPMB Option or FEMDPMB Accessory
Material: 304 Stainless Steel
pictured less bail wire

© 2012-2023 Acuity Brands Lighting, Inc. All rights reserved.

OPERATIONAL DATA (80 CRI*, MD**, MVOLT***)

Length	Package	Input Wattage	CCT	Frosted Lens' Lumens (LPW)				Clear Lens' Lumens (LPW)		
				IMAFL	IMAFD	LPAFL	LPPFL	IMACD	LPACL	LPPCL
L24	2000LM	13.4	30K	1962 (147)	2083 (156)	2076 (155)	1861 (139)	2112 (158)	2105 (158)	1890 (142)
			35K	2002 (150)	2126 (159)	2118 (159)	1899 (142)	2155 (161)	2147 (161)	1929 (144)
			40K	2099 (157)	2228 (167)	2220 (166)	1991 (149)	2259 (169)	2251 (169)	2022 (151)
			50K	2122 (159)	2252 (169)	2244 (168)	2013 (151)	2284 (171)	2276 (170)	2044 (153)
	3000LM	19.9	30K	2869 (144)	3046 (153)	3035 (153)	2721 (137)	3088 (155)	3077 (155)	2764 (139)
			35K	2927 (147)	3108 (156)	3096 (156)	2777 (140)	3151 (158)	3139 (158)	2820 (142)
			40K	3069 (154)	3258 (164)	3246 (163)	2911 (146)	3303 (166)	3291 (166)	2956 (149)
			50K	3102 (156)	3293 (166)	3281 (165)	2942 (148)	3339 (168)	3327 (167)	2988 (150)
	4000LM	26.0	30K	3676 (142)	3903 (150)	3889 (150)	3487 (134)	3957 (152)	3943 (152)	3541 (136)
			35K	3751 (145)	3982 (153)	3968 (153)	3558 (137)	4037 (156)	4023 (155)	3613 (139)
			40K	3932 (152)	4174 (161)	4159 (160)	3730 (144)	4232 (163)	4217 (162)	3788 (146)
			50K	3975 (153)	4219 (163)	4204 (162)	3770 (145)	4278 (165)	4263 (164)	3829 (148)
	6000LM	39.2	30K	5287 (135)	5613 (143)	5593 (143)	5015 (128)	5691 (145)	5671 (145)	5093 (130)
			35K	5395 (138)	5727 (146)	5707 (145)	5117 (130)	5806 (148)	5786 (147)	5196 (132)
			40K	5655 (144)	6004 (153)	5982 (153)	5364 (137)	6087 (155)	6065 (155)	5447 (139)
			50K	5717 (146)	6069 (155)	6047 (154)	5422 (138)	6153 (157)	6131 (156)	5506 (140)
L48	3000LM	18.0	30K	2689 (149)	2855 (158)	2844 (158)	2551 (141)	2894 (160)	2884 (160)	2590 (144)
			35K	2743 (152)	2912 (161)	2902 (161)	2602 (144)	2953 (164)	2942 (163)	2643 (146)
			40K	2876 (159)	3053 (169)	3042 (169)	2728 (151)	3095 (172)	3084 (171)	2770 (154)
			50K	2907 (161)	3086 (171)	3075 (170)	2758 (153)	3129 (173)	3118 (173)	2800 (155)
	4000LM	23.8	30K	3543 (149)	3762 (158)	3748 (157)	3361 (141)	3814 (160)	3800 (160)	3413 (143)
			35K	3615 (152)	3838 (161)	3824 (161)	3429 (144)	3891 (163)	3877 (163)	3482 (146)
			40K	3790 (159)	4023 (169)	4009 (168)	3595 (151)	4079 (171)	4064 (171)	3650 (153)
			50K	3831 (161)	4067 (171)	4052 (170)	3634 (153)	4123 (173)	4109 (173)	3690 (155)
	6000LM	37.8	30K	5284 (140)	5609 (149)	5589 (148)	5012 (133)	5687 (151)	5667 (150)	5090 (135)
			35K	5391 (143)	5723 (152)	5703 (151)	5114 (135)	5802 (154)	5782 (153)	5193 (138)
			40K	5651 (150)	6000 (159)	5978 (158)	5361 (142)	6083 (161)	6061 (161)	5444 (144)
			50K	5713 (151)	6065 (161)	6043 (160)	5419 (144)	6149 (163)	6127 (162)	5503 (146)
	8000LM	50.5	30K	6952 (138)	7380 (146)	7354 (146)	6594 (131)	7482 (148)	7456 (148)	6696 (133)
			35K	7093 (141)	7530 (149)	7503 (149)	6728 (133)	7634 (151)	7607 (151)	6832 (135)
			40K	7435 (147)	7894 (156)	7865 (156)	7053 (140)	8003 (159)	7975 (158)	7162 (142)
			50K	7516 (149)	7979 (158)	7950 (158)	7129 (141)	8090 (160)	8061 (160)	7240 (144)
	10000LM	62.0	30K	8646 (140)	9179 (148)	9146 (148)	8201 (132)	9306 (150)	9273 (150)	8328 (134)
			35K	8822 (142)	9365 (151)	9332 (151)	8368 (135)	9495 (153)	9461 (153)	8497 (137)
			40K	9248 (149)	9817 (158)	9782 (158)	8772 (142)	9953 (161)	9918 (160)	8908 (144)
			50K	9348 (151)	9924 (160)	9888 (160)	8867 (143)	10061 (162)	10026 (162)	9004 (145)
	12000LM	75.0	30K	10406 (139)	11047 (147)	11007 (147)	9871 (132)	11200 (149)	11160 (149)	10024 (134)
			35K	10617 (141)	11271 (150)	11231 (150)	10071 (134)	11427 (152)	11387 (152)	10227 (136)
			40K	11130 (148)	11816 (157)	11773 (157)	10557 (141)	11979 (160)	11937 (159)	10721 (143)
			50K	11251 (150)	11944 (159)	11901 (159)	10672 (142)	12109 (161)	12066 (161)	10837 (144)
L96	9000LM	53.4	30K	7962 (149)	8452 (158)	8422 (158)	7552 (141)	8570 (160)	8539 (160)	7669 (144)
			35K	8124 (152)	8624 (161)	8593 (161)	7706 (144)	8743 (164)	8713 (163)	7825 (146)
			40K	8516 (159)	9040 (169)	9008 (169)	8078 (151)	9166 (172)	9133 (171)	8203 (154)
			50K	8608 (161)	9138 (171)	9106 (170)	8165 (153)	9265 (173)	9232 (173)	8292 (155)
	12000LM	75.5	30K	10570 (140)	11221 (149)	11181 (148)	10026 (133)	11377 (151)	11337 (150)	10182 (135)
			35K	10785 (143)	11449 (152)	11408 (151)	10230 (135)	11608 (154)	11567 (153)	10388 (138)
			40K	11306 (150)	12002 (159)	11959 (158)	10724 (142)	12168 (161)	12125 (161)	10890 (144)
			50K	11428 (151)	12132 (161)	12089 (160)	10840 (144)	12300 (163)	12257 (162)	11008 (146)
	15000LM	94.3	30K	13399 (142)	14225 (151)	14174 (150)	12710 (135)	14422 (153)	14371 (152)	12907 (137)
			35K	13671 (145)	14513 (154)	14461 (153)	12968 (138)	14714 (156)	14662 (156)	13169 (140)
			40K	14331 (152)	15214 (161)	15160 (161)	13594 (144)	15425 (164)	15370 (163)	13805 (146)
			50K	14487 (154)	15379 (163)	15324 (163)	13741 (146)	15592 (165)	15537 (165)	13954 (148)
	18000LM	103.4	30K	15901 (154)	16881 (163)	16820 (163)	15083 (146)	17114 (165)	17054 (165)	15317 (148)
			35K	16224 (157)	17223 (167)	17161 (166)	15389 (149)	17462 (169)	17400 (168)	15627 (151)
			40K	17007 (164)	18055 (175)	17990 (174)	16132 (156)	18305 (177)	18240 (176)	16382 (158)
			50K	17192 (166)	18251 (176)	18185 (176)	16307 (158)	18503 (179)	18438 (178)	16560 (160)
	20000LM	125.5	30K	17549 (140)	18630 (148)	18564 (148)	16646 (133)	18888 (150)	18822 (150)	16904 (135)
			35K	17906 (143)	19008 (151)	18940 (151)	16984 (135)	19272 (154)	19204 (153)	17247 (137)
			40K	18770 (150)	19927 (159)	19855 (158)	17804 (142)	20202 (161)	20131 (160)	18080 (144)
			50K	18974 (151)	20143 (160)	20070 (160)	17997 (143)	20421 (163)	20349 (162)	18276 (146)
	24000LM	149.5	30K	21142 (141)	22445 (150)	22364 (150)	20055 (134)	22756 (152)	22675 (152)	20365 (136)
			35K	21571 (144)	22900 (153)	22818 (153)	20461 (137)	23217 (155)	23135 (155)	20779 (139)
			40K	22613 (151)	24006 (161)	23920 (160)	21450 (143)	24339 (163)	24253 (162)	21782 (146)
			50K	22858 (153)	24266 (162)	24179 (162)	21682 (145)	24602 (165)	24516 (164)	22018 (147)

* For 90CRI, reduce lumen output by 17.1%
** For WD reduce output by 4.7%, PGD reduce output by 5.4%
*** For HVOLT use scale factor in HVOLT SCALE FACTOR TABLE

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

© 2012-2023 Acuity Brands Lighting, Inc. All rights reserved.

CSA LISTED AMBIENT RATING*

		Standard** (surface)"	Standard** (suspended)"	E10WMCP (surface)	E10WMCP (suspended)	BE6WCP (surface)	BE6WCP (suspended)
L24	2000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	3000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	4000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	6000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
L48	3000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	4000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	6000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	8000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	10000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	12000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
L96	9000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	12000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	15000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	18000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	20000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	24000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C

*Minimum Ambient is -30°C unless noted.
**All options not specifically listed in this table are considered standard

HVOLT SCALE FACTOR

	Factor
2000LM	0.814
3000LM	0.814
4000LM	0.814
6000LM	0.835
8000LM	0.845
9000LM	0.850
10000LM	0.850
12000LM	0.845
15000LM	0.860
18000LM	0.880
20000LM	0.845
24000LM	0.865

CONFIGURATION WEIGHTS

	Standard	w/ Sensor	w/ Battery
L24	8	9	9
L48	11	12	12
L96	23	24	24

NUMBER OF BOARDS AND DRIVERS

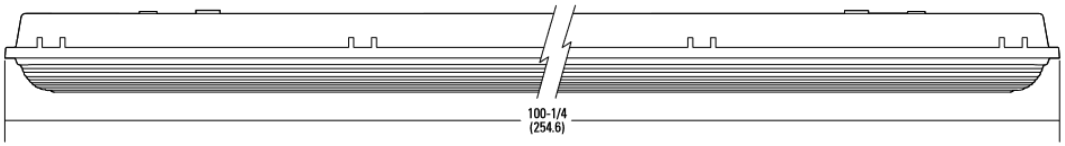
Lumen package	Fixture length	Number of boards	Number of drivers
2000LM	L24	1	1
3000LM		1	1
4000LM		1	1
6000LM		1	1
3000LM	L48	2	1
4000LM		2	1
6000LM		2	1
8000LM		2	1
10000LM		2	1
12000LM		2	1
9000LM	L96	4	1
12000LM		4	2
15000LM		4	2
18000LM		4	2
20000LM		4	2
24000LM		4	2

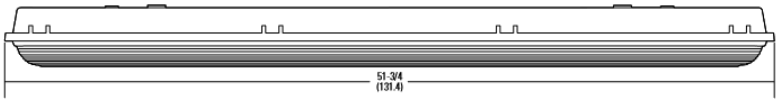
© 2012-2023 Acuity Brands Lighting, Inc. All rights reserved.

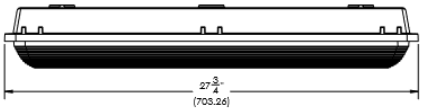
DIMENSIONS

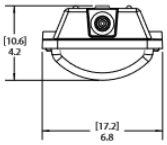
Specifications subject to change without notice.
All dimensions are inches (centimeters) unless otherwise indicated.

Weight (may vary with options or accessories)
FEM L48: 11.9 lbs (5.397kg)
FEM L96: 24.3 lbs (11.022kg)

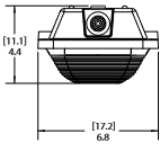




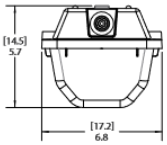




Diffuser Type:
LPAFL
LPACL
LPPFL
LPPCL



Diffuser Type:
IMAFL



Diffuser Type:
IMAFD
IMACD

PHOTOMETRICS

See www.lithonia.com for photometry reports.

© 2012-2023 Acuity Brands Lighting, Inc. All rights reserved.

EQUIPMENT	
MANUFACTURER	Lithonia Lighting
CATALOG NUMBER	FEM-L96-9000LM-LPPFL-MD-MVOLT-GZ10 -30K-80CRI
TOTAL WATTS	
VOLTAGE	120-277
MOUNTING	Surface
WEIGHT	24.3 LBS
DIMENSIONS	100.25" x 17.2" x 10.6"
FINISH	
RATING	IP67
LISTING	UL Wet Listed
SOURCE	
MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000k
CRI	80+
LUMEN OUTPUT	9000
ANTICIPATED LIFE	
POWER SUPPLY	
TYPE	Integral
PROVIDED BY	
ACCESSORIES	

Surface mount fixed linear with one (1) LED lighting source, 9000 delivered lumens, 3000k color engine, 80+ CRI, frosted optic and integral driver. Linear should operate on 120-277 voltage and be supplied with a 0-10v control option and include a minimum 5-year warranty. Linear to be rated for IP67 or equivalent. Linear should be UL listed for wet use or an approved equivalent.

CONTROL	
PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — A general purpose and energy-efficient surface-mounted or suspended LED fixture, suitable for wet, damp and/or cold locations. For vapor-tight demanding environments where moisture or dust is a concern and where relatively low fixture mounting heights and wide fixture spacing are common. Not for use or installation in direct outdoor sunlight. Must be installed under canopy or covered ceiling. For direct sunlight installations, please refer to the FEX product family. Typical applications include industrial facilities, parking garages, retail malls, multi-purpose rooms, garden centers, and food processing. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** **Click here for Acrylic-Polycarbonate Compatibility table for suitable use.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. **Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.**

CONSTRUCTION — One-piece 5VA fiberglass housing with integral perimeter channel utilizing continuous poured-in-place NEMA 4X gasket. Approved for through wiring. Captive polymeric latches are standard. Stainless steel latches (316SS) available as an option for food processing or more demanding applications.

Power connection is easily accomplished through pre-drilled holes.

OPTICS — Injection molded, acrylic lens (.080" thick) provides high impact-resistance comparable to 100% DR. A UV stabilized polycarbonate diffuser is available (.080" thick) in clear or frosted for additional impact strength where vandal protection is desired.

Expected service life of 60,000 hours at 80% lumen maintenance (L80); predicted life of more than 100,000 hours.

ELECTRICAL — Utilizes high-efficiency LEDs mounted to core circuit boards. High-efficiency drivers operate 120-277 (MVOLT) and 347-480 (HVOLT) offered with 0-10 volt dimming, dims to 10%. Standard Luminaire Surge Protection Level: 6kV/3kA Surge Rated per ANSI C82.77-5-2015.

INSTALLATION — A pair of stainless steel (316SS) surface mount brackets (SMB) are included (unless another mounting option is chosen) allowing for surface (ceiling) or suspension mount applications using included bail with aircraft cable or chain. Optional pair of dual pendant mount brackets (DPMB) (316SS) are available for surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain. Optional pair of angle mounting brackets (ANGBKT) (316SS) for horizontal wall mount applications.

LISTINGS — CSA Certified to UL and C-UL Standards. Suitable for wet location. IP65, IP66, IP67 and IP69K (optional) rated. NSF Splash Zone 2 and Non-Food Zone rated. NEMA Type 4X rated. Sensors maintain IP65 and IP66 only. See chart on page 5 for Ambient Temperatures.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

GOVERNMENT PROCUREMENT — BAA – Product with the BAA option qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product with the BAA option also qualifies as manufactured in the United States under DOT Buy America regulations.
BABA – Build America Buy America: Product with the BAA option also qualifies as produced in the United States under the definitions of the Build America, Buy America Act.
Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Low-Profile Enclosed and Gasketed Industrial

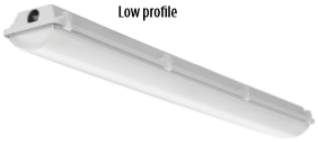
FEM LED

SURFACE/ SUSPENDED/WALL MOUNT

Deep Lens

Low profile with sensor

Low profile



design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

FEM LED Low-Profile Enclosed and Gasketed

Design Select options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: FEM L48 4000LM IMAFL WD MVOLT GZ10 40K 80CRI

Series	Length	Nominal Lumens	Diffuser	Distribution	Voltage	Driver	Color temperature	CRI
FEM	L24 24" ‡	2000LM 2,000 lumens 3000LM 3,000 lumens 4000LM 4,000 lumens 6000LM 6,000 lumens	IMAFL Acrylic, lineal ribbed frosted lens IMACD Acrylic, clear deep lens IMAFD Acrylic, deep frosted lens LPAFL Acrylic, low profile frosted lens LPACL Acrylic, low profile clear lens LPPCL Polycarbonate, low profile clear lens LPPFL Polycarbonate, low profile frosted lens	MD Medium WD Wide PGD Parking garage	MVOLT 120-277V HVOLT 347-480V ‡ 120 120V 208 208V 240 240V 277 277V 347 347V 480 480V	GZ10 0 - 10V dimming	30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80 CRI 90CRI 90 CRI
	L48 48" ‡	3000LM 3,000 lumens 4000LM 4,000 lumens 6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens 12000LM 12,000 lumens						
	L96 96" ‡	9000LM 9,000 lumens 12000LM 12,000 lumens 15000LM 15,000 lumens 18000LM 18,000 lumens 20000LM 20,000 lumens 24000LM 24,000 lumens						

Options

Emergency:

BE6WCP	6W internal cold battery, illuminated test switch, cold rated -20°C min, wet location, Certified in CA Title 20 MAEDBS ‡
E10WMCP	10W internal constant power battery, self-diagnostic test switch, 5°C min, wet location, Certified in CA Title 20 MAEDBS ‡
E7W2H	7W internal constant power battery, illuminated test switch, 2hr operation, 0°C min, wet location, Certified in CA Title 20 MAEDBS ‡
ETS	Emergency lighting control device for UL924 operation when using auxiliary generator or central inverter ‡
247OP	24/7 Operation with emergency battery and 3 conductor cord or plug ‡

Mounting:

ANGBKT	Angle bracket shipped with fixture (316SS) ‡
DPMB	Dual pendant mounting bracket (316SS) ‡
EMK	(2) End mount suspension brackets (304SS) ‡
QMB	(2) Quick mount brackets (304SS) ‡
WLF	Wet location fitting (two outboard, top (L24 - 20 inches off-center, L48 - 48 inches off-center, L96 - 95.7 inches off-center) ‡
WLFEND	Wet location fitting (one end) ‡
WLFEND2	Wet location fitting (both ends) ‡
WLFPMP	Wet location pendant monopoint ‡
WLF4X	Wet location fittings, NEMA Type 4X rated ‡
WLFPMP4X	Wet location fitting for pendant mounting, NEMA Type 4X rated ‡
WLFEND4X	Wet location one end, NEMA Type 4X fittings ‡
WLFEND24X	Wet Location both-ends, NEMA Type 4X fittings ‡

Other Options:

A0	Adjustable output dimming ‡
DL	Damp Location ‡
DRYLBL	Dry Location ‡
IP69K	IP69K rating, includes vent plugs ‡
SPD	Surge protection device, additional 10kV/6kA
STSL	Stainless steel latches (316SS)
TRS	Tamper Resistant Torx® T10 screws (18-8SS)
BAA	Buy America(n) Act and/or Build America Buy America Qualified

Cordsets:

CNP16WWL	Cord, no plug, 16 gauge, 3 conductors, white, wet locations, 6 feet, other lengths available ‡
CNP164CWWL	Cord, no plug, 16 gauge, 4 conductors for use with EM battery, white, wet locations, 6 feet, other lengths available ‡
CNP165CWWL	Cord, no plug, 16 gauge, 5 conductors for use with ER controls or ETS device with 2 power sources, white, wet locations, 6 feet, other lengths available ‡
CNP165CDWWL	Cord, no plug, 16 gauge, 5 conductors for 0-10V dimming, white, wet locations, 6 feet, other lengths available ‡
CPTL16W	Cord with NEMA twist lock 15 amp plug, 16 gauge, 3 conductors, white, damp location, 6 feet, other lengths available
CPTL16WWL	Cord with NEMA twist lock 15 amp plug, 16 gauge, 3 conductors, white, wet location, 6 feet, other lengths available
CPTL20A16W	Cord with NEMA twist lock 20 amp plug, 16 gauge, 3 conductors white, damp location, 6 feet, other lengths available
CPTL20A16WWL	Cord with NEMA twist lock 20 amp plug, 16 gauge, 3 conductors white, wet location, 6 feet, other lengths available
CPSB16W	Cord with NEMA straight blade 15 amp plug, 18 gauge, 3 conductors white, damp location, 6 feet, other lengths available
CMCMBH16YWL	Cord with Brad Mini Change® male connector, nonmetallic coupling nut, 3 pole, 16 gauge, yellow, wet location, 6 feet, other lengths available ‡
MCRMBH16WL	Receptacle with Brad Mini Change® male connector, stainless steel coupling nut, 3 pole, 16 gauge leads, wet location ‡

See chart for additional cordset options

Reloc®:

OCS	Reloc® One Pass® circuit selector system drop, 18 gauge, 3 conductors, 6 feet, other lengths available ‡
OCS4C	Reloc® One Pass® circuit selector system drop, 18 gauge, 4 conductors, for use with EM battery, 6 feet, other lengths available ‡

See chart for additional Reloc® options

Sensor Switch Embedded Controls:

SBOR10	360° Low Mount Sensor, (8-15' mounting heights, more options available), on/off occupancy, Sensor/control mounted external to the luminaire via a KO ‡
SBOR10 D 3V	360° Low Mount Sensor, (8-15' mounting heights, more options available), high/low/off occupancy dimming, Sensor/control mounted external to the luminaire via a KO ‡
SBOR10 P	360° Low Mount Sensor, (8-15' mounting heights, more options available), on/off photocell, Sensor/control mounted external to the luminaire via a KO ‡

See chart for additional control options

nLight Embedded Controls:

NLTAIR2	Embedded wireless controls by nLight ‡
NLTAIREM2	Embedded wireless controls by nLight with UL924 listed emergency operation ‡
NLTAIRER2	Embedded wireless controls by nLight with UL924 listed emergency operation via power sense leads ‡
NLTAIR2 APIRKO	Embedded wireless controls by nLight, Passive Infrared Occ sensor with auto-dimming photocell, Sensor/control mounted external to the luminaire via a KO ‡
NLTAIREM2 APIRKO	Embedded wireless controls by nLight with UL924 listed emergency operation, Passive Infrared Occ sensor with auto-dimming photocell, Sensor/control mounted external to the luminaire via a KO ‡
NLTAIRER2 APIRKO	Embedded wireless controls by nLight with UL924 listed emergency operation via power sense leads, Passive Infrared Occ sensor with auto-dimming photocell, Sensor/control mounted external to the luminaire via a KO ‡

See chart for additional control options

NOTE: ‡ indicates option chosen has ordering restrictions. Please reference ordering restrictions chart, page 3. Options are sorted alphanumerically.

See Accessories and ordering restrictions on next page.

INDUSTRIAL: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) www.lithonia.com

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

Accessories: *Order as separate catalog number.*					
MHCH 36	3 foot (36 inches) jack chain (pair)	RK1 T10BIT W/PIN U	Hex-base driver bit, Torx TX10, for tamper resistant screws with center reject pin	FEMSMB	Surface mount bracket (ships as pair) (316SS) ‡
MHHK120	10 foot (120 inches) single leg air craft cable (ships as pair)	FEMDPMB	Dual pendant mounting bracket (ships as a pair) (316SS) ‡	FEMEMK	End mount suspension brackets (ships as a pair) (304SS) ‡
MHHK120SS	10 foot (120 inches) single leg air craft cable, stainless steel (ships as pair)	FEMANGBKT	Angle bracket (ships as pair) (316SS) ‡	FEMQMB	Quick mount brackets (ships as pair) (304SS) ‡

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
2470P	Required when an EM battery and a 3 conductor cordset is selected. The driver and EM battery power inputs will be tied together and the fixture will be not be able to be turned off without controls. When ordered with a cordset that includes a plug, the max cord length will be 3 feet. Consult local codes to determine if this is allowable.
ANGBKT	For wall mount applications. If mounted in an upward orientation, fixture will be damp location listed only.
AO	Not available with L24. Not available with Sensor Switch embedded dimming controls, nLight embedded controls, 5 conductor dual voltage (CNP165C) or 5 conductor dimming (CNP165CD) cordsets. Available with non-dimming Sensor Switch embedded controls (SBOR6 or SBOR10; occupancy only).
BE6WCP	Utilizes Bodine® BSL36 Cold-Pak emergency driver. Not available with L24 length, 347, 480 or HVOLT. Available with 4 conductor (CNP164C) cordsets. Also available with 3 conductor (CNP16) cordsets or a cordset with a plug (CPTL16, CPTL20A16). Plug requires 2470P option.
CMCMBH16YWL	Not available with ETS, ER controls or WLFEND2. Not NEMA Type 4X rated.
CNP164CWWL	Not available with ETS, ER controls or WLFEND2. Not NEMA Type 4X rated. When damp location is required, remove the WL from the nomenclature.
CNP165CDWWL	Not available with ETS, AO, Sensor Switch embedded dimming controls, nLight embedded controls or WLFEND2. Available with non-dimming Sensor Switch embedded controls (SBGR; occupancy only). 2470P required when ordered with EM batteries. **Not NEMA Type 4X rated.** When damp location is required, remove the WL from the nomenclature.
CNP165CWWL	Available with ETS or ER controls only. Not NEMA Type 4X rated.
CNP16WWL	Not available with BE6WCP, E10WMCP or WLFEND2. 2470P required when ordered with EM batteries. **Not NEMA Type 4X rated.** When damp location is required, remove the WL from the nomenclature.
CPSBW	Damp Location only. Not available with ETS or ER controls. When ordered with EM battery, 2470P is required. **Not NEMA Type 4X rated.**
CPTL16W, CPTL20A16W	Damp Location only. Not available with ETS or ER controls. When ordered with EM batteries, 2470P is required. **Not NEMA Type 4X rated.**
CPTL16WWL, CPTL20A16WWL	Not available with ETS or ER controls. When ordered with EM batteries, 2470P is required. **Not NEMA Type 4X rated.**
DL	Required with damp location cords such as CNPW or CPSBW.
DPMB	Replaces standard surface mount bracket. For surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain.
DRYLBL	Required with OCS and OCS4C.
EMK	Requires the WLFEND2 option.
E7W2H	Utilizes IOTA® ILB CP07 2H battery. UL924 compliant. Not available with L24, ETS, ER Controls 347, 480 or HVOLT. Available with 4 conductor (CNP164C) cordsets. Available with 3 conductor (CNP16, CPTL16, CPTL20A16) cordsets with 2470P option. Consult local codes to determine if this is allowable.
E10WMCP	Utilizes Power Sentry® PS1055MCP battery. Not available with ETS, ER Controls 347, 480 or HVOLT. Available with 4 conductor (CNP164C) cordsets. Also available with 3 conductor (CNP16) cordsets or a cordset with a plug (CPTL16, CPTL20A16). Plug requires 2470P option. Consult local codes to determine if this is allowable.
ETS	Not available with EM batteries (E10WMCP, BE6WCP), EM or ER controls. 120-277V only. Available with a 5 conductor dual voltage cordset (CNP165C), but not required. Utilizes IOTA ETS DR emergency lighting control device.
FEMANGBKT	For wall mount applications. If mounted in an upward orientation, fixture will be damp location listed only.
FEMDPMB	For surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain.
FEMSMB	Replacement only; ships standard with fixture (unless another mounting option is chosen). For surface (ceiling) or suspension mount applications using included bail with aircraft cable or chain.
FEMQMB	For surface mount applications.
HVOLT	When ordered with L24, available with 6000LM only. When L24 with 2000LM, 3000LM, or 4000LM requires 347 or 480 voltage to be specified. Not available with HVOLT. Utilizes a step-down transformer when 347 and 480V are required. When ordered with L48, not available with 3000LM or 4000LM.
IP69K	Requires STSL option. Not available with wet location fittings (WLF, WLFEND, WLFEND2), any cordset, any battery pack, or any sensor.
L24	Not available with BE6WCP or AO options.
L48	Not available with WLFPMP options.
L96	Not available with WLFPMP options.
MCRMBH16WL	Not available with WLFEND2. 2470P required when ordered with EM batteries. **Not NEMA Type 4X rated.**
NLTAIR2 APIRKO, NLTAIREM2 APIRKO, NLTAIRER2 APIRKO	Not available WLFEND2. **Not NEMA Type 4X rated. IP65 and IP66 rated.**
NLTAIR2, NLTAIREM2, NLTAIRER2	**Not NEMA Type 4X rated. IP65 and IP66 rated.**
OCS DRYLBL	Dry location label required. When ordered with a battery, 2470P option is required.
OCS4C DRYLBL	Dry location label required. For use when battery option is ordered and battery requires unswitched hot.
QMB	Replaces standard surface mount bracket. For surface mount applications.
SBOR10, SBOR10 D 3V, SBOR10 P	Not available with WLFEND2. **IP65 and IP66 rated. Not NEMA Type 4X rated.** If high mount sensor is required, remove 10 from nomenclature and replace with 6. EX: SBOR6
WLF	In addition to top mounted fittings, includes (2) Pre-drilled 7/8" holes with water tight plugs (both ends). L24 - 20 inches off-center, L48 - 48 inches off-center, L96 95.7 inches off-center. If cord is ordered, cord will exit from the end of the fixture. Not available with SBOR or APIRKO options. **Not NEMA Type 4X rated.**
WLF4X	In addition to top mounted fittings, includes (2) Pre-drilled 7/8" holes with water tight plugs (both ends). L24 - 20 inches off-center, L48 - 48 inches off-center, L96 95.7 inches off-center. If cord is ordered, cord will exit from the end of the fixture.
WLFEND	Includes (1) Pre-drilled 7/8" hole with water tight plug (opposite end). If cord is ordered, cord will exit from the end of the fixture. Available with cord or sensor option. Choose only one. **Not NEMA Type 4X rated.**
WLFEND2	Available with NLTAIR2, NLTAIREM2 or NLTAIRER2 (nLight air RIO only). Not available with NLTAIR2 APIRKO, NLTAIREM2 APIRKO or NLTAIRER2 APIRKO (nLight air sensors), SBOR sensors or any cord option. **Not NEMA Type 4X rated.**
WLFEND24X	Not available with sensor or cord options.
WLFEND4X	Includes (1) Pre-drilled 7/8" hole with water tight plug (opposite end). If cord is ordered, cord will exit from the end of the fixture. Available with cord or sensor option. Choose only one.
WLFPMP	In addition to the one top mounted fitting, includes (2) Pre-drilled 7/8" holes with water tight plugs (both ends). **Not NEMA Type 4X rated.**
WLFPMP4X	In addition to the one top mounted fitting, includes (2) Pre-drilled 7/8" holes with water tight plugs (both ends).

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

OPERATING CHARACTERISTICS ‡

Input Watts ‡	Length	Lumen Package	Distribution	Lens	80CRI	90CRI	80CRI	90CRI	80CRI	90CRI	80CRI	90CRI	
					3000K		3500K		4000K		5000K		
13	L24	2000LM	MD	IMACD	2189	1849	2215	1913	2279	1952	2279	1952	Lumens
					168	142	170	147	175	150	175	150	LPW
				IMAFD	2170	1833	2196	1897	2259	1935	2259	1935	Lumens
					167	141	169	146	174	149	174	149	LPW
				IMAFL	2047	1729	2071	1789	2131	1825	2131	1825	Lumens
					157	133	159	138	164	140	164	140	LPW
				LPACL	2155	1820	2180	1883	2244	1921	2244	1921	Lumens
					166	140	168	145	173	148	173	148	LPW
				LPAFL	2156	1821	2181	1884	2245	1922	2245	1922	Lumens
					166	140	168	145	173	148	173	148	LPW
				LPPCL	2176	1838	2202	1902	2265	1940	2265	1940	Lumens
					167	141	169	146	174	149	174	149	LPW
				LPPFL	1938	1637	1961	1694	2018	1728	2018	1728	Lumens
					149	126	151	130	155	133	155	133	LPW
20	L24	3000LM	MD	IMACD	3250	2745	3288	2840	3384	2898	3384	2898	Lumens
					163	137	164	142	169	145	169	145	LPW
				IMAFD	3222	2721	3260	2816	3354	2872	3354	2872	Lumens
					161	136	163	141	168	144	168	144	LPW
				IMAFL	3039	2567	3075	2656	3164	2709	3164	2709	Lumens
					152	128	154	133	158	135	158	135	LPW
				LPACL	3199	2702	3237	2796	3331	2852	3331	2852	Lumens
					160	135	162	140	167	143	167	143	LPW
				LPAFL	3201	2703	3239	2797	3332	2854	3332	2854	Lumens
					160	135	162	140	167	143	167	143	LPW
				LPPCL	3230	2728	3268	2823	3363	2880	3363	2880	Lumens
					162	136	163	141	168	144	168	144	LPW
				LPPFL	2877	2430	2911	2515	2996	2565	2996	2565	Lumens
					144	122	146	126	150	128	150	128	LPW
26	L24	4000LM	MD	IMACD	4370	3691	4422	3819	4550	3896	4550	3896	Lumens
					168	142	170	147	175	150	175	150	LPW
				IMAFD	4332	3659	4383	3786	4510	3862	4510	3855	Lumens
					167	141	169	146	173	149	173	148	LPW
				IMAFL	4086	3451	4134	3571	4254	3643	4254	3643	Lumens
					157	133	159	137	164	140	164	140	LPW
				LPACL	4302	3633	4352	3759	4478	3835	4478	3835	Lumens
					165	140	167	145	172	148	172	148	LPW
				LPAFL	4304	3635	4355	3761	4481	3837	4481	3837	Lumens
					166	140	168	145	172	148	172	148	LPW
				LPPCL	4344	3669	4395	3796	4522	3872	4522	3872	Lumens
					167	141	169	146	174	149	174	149	LPW
				LPPFL	3869	3268	3914	3381	4028	3449	4028	3449	Lumens
					149	126	151	130	155	133	155	133	LPW
41	L24	6000LM	MD	IMACD	6507	5495	6583	5686	6774	5801	6774	5801	Lumens
					159	134	161	139	165	141	165	141	LPW
				IMAFD	6450	5447	6526	5637	6715	5750	6715	5750	Lumens
					157	133	159	137	164	140	164	140	LPW
				IMAFL	6083	5138	6155	5316	6333	5423	6333	5423	Lumens
					148	125	150	130	154	132	154	132	LPW
				LPACL	6404	5409	6480	5597	6667	5710	6667	5710	Lumens
					156	132	158	137	163	139	163	139	LPW
				LPAFL	6408	5412	6483	5600	6671	5713	6671	5713	Lumens
					156	132	158	137	163	139	163	139	LPW
				LPPCL	6467	5462	6543	5651	6732	5765	6732	5765	Lumens
					158	133	160	138	164	141	164	141	LPW
				LPPFL	5760	4865	5828	5034	5997	5135	5997	5135	Lumens
					140	119	142	123	146	125	146	125	LPW

Notes ‡	
Input Watts	120VAC.
Operating Characteristics	Absolute photometry calculated in accordance with IESNA LM-79-08 @ 25°C.

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

OPERATING CHARACTERISTICS ‡

Input Watts ‡	Length	Lumen Package	Distribution	Lens	80CRI 3000K	90CRI 3000K	80CRI 3500K	90CRI 3500K	80CRI 4000K	90CRI 4000K	80CRI 5000K	90CRI 5000K	
19	L48	3000LM	MD	IMACD	3002	2536	3038	2624	3126	2677	3126	2677	Lumens
					158	133	160	138	165	141	165	141	LPW
				IMAFD	2976	2514	3011	2601	3098	2653	3098	2653	Lumens
					157	132	158	137	163	140	163	140	LPW
				IMAFL	2807	2371	2840	2453	2922	2503	2922	2503	Lumens
					148	125	149	129	154	132	154	132	LPW
				LPACL	2955	2496	2990	2583	3077	2635	3077	2635	Lumens
					156	131	157	136	162	139	162	139	LPW
				LPAFL	2957	2497	2992	2584	3078	2636	3078	2636	Lumens
					156	131	157	136	162	139	162	139	LPW
				LPPCL	2984	2520	3019	2608	3107	2660	3107	2660	Lumens
					157	133	159	137	164	140	164	140	LPW
				LPPFL	2658	2245	2689	2323	2767	2370	2767	2370	Lumens
					140	118	142	122	146	125	146	125	LPW
24	L48	4000LM	MD	IMACD	4017	3393	4064	3510	4182	3581	4182	3581	Lumens
					167	141	169	146	174	149	174	149	LPW
				IMAFD	3982	3363	4029	3480	4145	3550	4145	3550	Lumens
					166	140	168	145	173	148	173	148	LPW
				IMAFL	3756	3172	3800	3282	3910	3348	3910	3348	Lumens
					157	132	158	137	163	140	163	140	LPW
				LPACL	3954	3339	4000	3455	4116	3525	4116	3525	Lumens
					165	139	167	144	172	147	172	147	LPW
				LPAFL	3956	3341	4002	3457	4118	3527	4118	3527	Lumens
					165	139	167	144	172	147	172	147	LPW
				LPPCL	3992	3372	4039	3489	4156	3559	4156	3559	Lumens
					166	141	168	145	173	148	173	148	LPW
				LPPFL	3556	3003	3598	3108	3702	3170	3702	3170	Lumens
					148	125	150	130	154	132	154	132	LPW
39	L48	6000LM	MD	IMACD	6424	5425	6499	5614	6687	5727	6687	5727	Lumens
					165	139	167	144	171	147	171	147	LPW
				IMAFD	6368	5378	6442	5565	6629	5677	6629	5677	Lumens
					163	138	165	143	170	146	170	146	LPW
				IMAFL	6006	5072	6076	5248	6252	5354	6252	5354	Lumens
					154	130	156	135	160	137	160	137	LPW
				LPACL	6323	5340	6397	5525	6582	5637	6582	5637	Lumens
					162	137	164	142	169	145	169	145	LPW
				LPAFL	6326	5343	6400	5528	6586	5640	6586	5640	Lumens
					162	137	164	142	169	145	169	145	LPW
				LPPCL	6384	5392	6459	5579	6646	5691	6646	5691	Lumens
					164	138	166	143	170	146	170	146	LPW
				LPPFL	5687	4803	5753	4970	5920	5070	5920	5070	Lumens
					146	123	148	127	152	130	152	130	LPW
51	L48	8000LM	MD	IMACD	8413	7106	8512	7352	8759	7500	8759	7500	Lumens
					165	139	167	144	172	147	172	147	LPW
				IMAFD	8340	7044	8438	7288	8682	7435	8682	7435	Lumens
					164	138	165	143	170	146	170	146	LPW
				IMAFL	7866	6643	7958	6874	8189	7012	8189	7012	Lumens
					154	130	156	135	161	137	161	137	LPW
				LPACL	8281	6994	8378	7237	8621	7383	8621	7383	Lumens
					162	137	164	142	169	145	169	145	LPW
				LPAFL	8285	6998	8383	7241	8626	7386	8626	7386	Lumens
					162	137	164	142	169	145	169	145	LPW
				LPPCL	8362	7062	8460	7307	8705	7454	8705	7454	Lumens
					164	138	166	143	171	146	171	146	LPW
				LPPFL	7448	6290	7535	6509	7754	6640	7754	6640	Lumens
					146	123	148	128	152	130	152	130	LPW

Notes ‡	
Input Watts	120VAC.
Operating Characteristics	Absolute photometry calculated in accordance with IESNA LM-79-08 @ 25°C.

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

OPERATING CHARACTERISTICS ‡

Input Watts ‡	Length	Lumen Package	Distribution	Lens	80CRI 3000K	90CRI 3000K	80CRI 3500K	90CRI 3500K	80CRI 4000K	90CRI 4000K	80CRI 5000K	90CRI 5000K	
63	L48	10000LM	MD	IMACD	9971	8421	10088	8714	10380	8889	10380	8889	Lumens
					158	134	160	138	165	141	165	141	LPW
				IMAFD	9884	8348	10000	8638	10290	8811	10290	8811	Lumens
					157	133	159	137	163	140	163	140	LPW
				IMAFL	9322	7873	9432	8147	9705	8311	9705	8311	Lumens
					148	125	150	129	154	132	154	132	LPW
				LPACL	9814	8289	9929	8577	10217	8749	10217	8749	Lumens
					156	132	158	136	162	139	162	139	LPW
				LPAFL	9820	8293	9935	8581	10223	8754	10223	8754	Lumens
					156	132	158	136	162	139	162	139	LPW
				LPPCL	9910	8370	10026	8660	10317	8835	10317	8835	Lumens
					157	133	159	137	164	140	164	140	LPW
				LPPFL	8827	7455	8931	7714	9189	7869	9189	7869	Lumens
					140	118	142	122	146	125	146	125	LPW
75	L48	12000LM	MD	IMACD	11776	9945	11914	10291	12259	10498	12259	10498	Lumens
					157	133	159	137	163	140	163	140	LPW
				IMAFD	11673	9859	11810	10201	12152	10406	12152	10406	Lumens
					156	131	157	136	162	139	162	139	LPW
				IMAFL	11009	9298	11139	9621	11461	9815	11461	9815	Lumens
					147	124	149	128	153	131	153	131	LPW
				LPACL	11591	9789	11727	10129	12066	10333	12066	10333	Lumens
					155	131	156	135	161	138	161	138	LPW
				LPAFL	11597	9794	11733	10134	12073	10338	12073	10338	Lumens
					155	131	156	135	161	138	161	138	LPW
				LPPCL	11703	9884	11841	10228	12184	10433	12184	10433	Lumens
					156	132	158	136	162	139	162	139	LPW
				LPPFL	10425	8804	10547	9110	10853	9293	10853	9293	Lumens
					139	117	141	121	145	124	145	124	LPW
53	L96	9000LM	MD	IMACD	8690	7340	8792	7594	9047	7747	9047	7747	Lumens
					164	138	166	143	171	146	171	146	LPW
				IMAFD	8614	7276	8715	7528	8968	7680	8968	7680	Lumens
					163	137	164	142	169	145	169	145	LPW
				IMAFL	8125	6862	8220	7100	8458	7243	8458	7243	Lumens
					153	129	155	134	160	137	160	137	LPW
				LPACL	8554	7224	8654	7475	8905	7626	8905	7626	Lumens
					161	136	163	141	168	144	168	144	LPW
				LPAFL	8558	7228	8659	7479	8910	7630	8910	7630	Lumens
					161	136	163	141	168	144	168	144	LPW
				LPPCL	8637	7295	8738	7548	8992	7700	8992	7700	Lumens
					163	138	165	142	170	145	170	145	LPW
				LPPFL	7693	6498	7783	6723	8009	6858	8009	6858	Lumens
					145	123	147	127	151	129	151	129	LPW
76	L96	12000LM	MD	IMACD	12487	10547	12634	10913	13000	11133	13000	11133	Lumens
					164	139	166	144	171	146	171	146	LPW
				IMAFD	12379	10455	12524	10818	12887	11035	12887	11035	Lumens
					163	138	165	142	170	145	170	145	LPW
				IMAFL	11675	9860	11812	10203	12154	10408	12154	10408	Lumens
					154	130	155	134	160	137	160	137	LPW
				LPACL	12291	10381	12436	10741	12796	10958	12796	10958	Lumens
					162	137	164	141	168	144	168	144	LPW
				LPAFL	12298	10386	12442	10747	12803	10963	12803	10963	Lumens
					162	137	164	141	168	144	168	144	LPW
				LPPCL	12411	10482	12556	10846	12920	11064	12920	11064	Lumens
					163	138	165	143	170	146	170	146	LPW
				LPPFL	11055	9337	11185	9661	11509	9855	11509	9855	Lumens
					145	123	147	127	151	130	151	130	LPW

Notes ‡	
Input Watts	120VAC.
Operating Characteristics	Absolute photometry calculated in accordance with IESNA LM-79-08 @ 25°C.

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

OPERATING CHARACTERISTICS ‡

Input Watts ‡	Length	Lumen Package	Distribution	Lens	80CRI	90CRI	80CRI	90CRI	80CRI	90CRI	80CRI	90CRI	
					3000K		3500K		4000K		5000K		
94	L96	15000LM	MD	IMACD	15528	13115	15710	13570	16166	13843	16166	13843	Lumens
					165	140	167	144	172	147	172	147	LPW
				IMAFD	15393	13000	15573	13452	16025	13723	16025	13723	Lumens
					164	138	166	143	170	146	170	146	LPW
				IMAFL	14518	12261	14688	12687	15114	12943	15114	12943	Lumens
					154	130	156	135	161	138	161	138	LPW
				LPACL	15284	12909	15464	13357	15912	13626	15912	13626	Lumens
					163	137	165	142	169	145	169	145	LPW
				LPAFL	15292	12916	15472	13364	15920	13633	15920	13633	Lumens
					163	137	165	142	169	145	169	145	LPW
				LPPCL	15433	13034	15614	13487	16067	13758	16067	13758	Lumens
					164	139	166	143	171	146	171	146	LPW
				LPPFL	13747	11610	13908	12013	14311	12255	14311	12255	Lumens
					146	124	148	128	152	130	152	130	LPW
105	L96	18000LM	MD	IMACD	16900	14273	17098	14769	17594	15066	17594	15066	Lumens
					161	136	163	141	168	143	168	143	LPW
				IMAFD	16752	14149	16949	14640	17440	14935	17440	14935	Lumens
					160	135	161	139	166	142	166	142	LPW
				IMAFL	15800	13345	15986	13808	16449	14086	16449	14086	Lumens
					150	127	152	132	157	134	157	134	LPW
				LPACL	16634	14049	16830	14537	17317	14830	17317	14830	Lumens
					158	134	160	138	165	141	165	141	LPW
				LPAFL	16643	14056	16838	14545	17327	14837	17327	14837	Lumens
					159	134	160	139	165	141	165	141	LPW
				LPPCL	16796	14186	16993	14678	17486	14974	17486	14974	Lumens
					160	135	162	140	167	143	167	143	LPW
				LPPFL	14961	12636	15137	13074	15575	13338	15575	13338	Lumens
					142	120	144	125	148	127	148	127	LPW
127	L96	20000LM	MD	IMACD	20400	17229	20639	17827	21237	18186	21237	18186	Lumens
					161	136	163	140	167	143	167	143	LPW
				IMAFD	20222	17079	20459	17672	21052	18027	21052	18027	Lumens
					159	134	161	139	166	142	166	142	LPW
				IMAFL	19072	16108	19296	16667	19855	17003	19855	17003	Lumens
					150	127	152	131	156	134	156	134	LPW
				LPACL	20079	16958	20315	17547	20904	17901	20904	17901	Lumens
					158	134	160	138	165	141	165	141	LPW
				LPAFL	20090	16967	20325	17556	20915	17910	20915	17910	Lumens
					158	134	160	138	165	141	165	141	LPW
				LPPCL	20275	17123	20512	17718	21107	18075	21107	18075	Lumens
					160	135	162	140	166	142	166	142	LPW
				LPPFL	18059	15252	18271	15782	18801	16100	18801	16100	Lumens
					142	120	144	124	148	127	148	127	LPW
150	L96	24000LM	MD	IMACD	23714	20028	23992	20724	24688	21141	24688	21141	Lumens
					158	134	160	138	165	141	165	141	LPW
				IMAFD	23507	19853	23783	20543	24472	20956	24472	20956	Lumens
					157	132	159	137	163	140	163	140	LPW
				IMAFL	22171	18725	22431	19375	23081	19765	23081	19765	Lumens
					148	125	150	129	154	132	154	132	LPW
				LPACL	23342	19714	23615	20398	24300	20809	24300	20809	Lumens
					156	131	157	136	162	139	162	139	LPW
				LPAFL	23354	19724	23628	20409	24313	20820	24313	20820	Lumens
					156	131	158	136	162	139	162	139	LPW
				LPPCL	23569	19905	23845	20597	24536	21011	24536	21011	Lumens
					157	133	159	137	164	140	164	140	LPW
				LPPFL	20993	17730	21240	18346	21855	18716	21855	18716	Lumens
					140	118	142	122	146	125	146	125	LPW

Notes ‡	
Input Watts	120VAC.
Operating Characteristics	Absolute photometry calculated in accordance with IESNA LM-79-08 @ 25°C.

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

LUMEN AMBIENT TEMPERATURE (LAT) MULTIPLIERS

L24		2000 LM	3000 LM	4000 LM	6000 LM
-30°C	-22°F	1.047	1.050	1.051	1.056
-20°C	-4°F	1.040	1.042	1.043	1.047
-10°C	14°F	1.032	1.033	1.034	1.038
0°C	32°F	1.024	1.025	1.025	1.027
10°C	50°F	1.015	1.015	1.016	1.017
20°C	68°F	1.005	1.005	1.005	1.006
25°C	77°F	1.000	1.000	1.000	1.000
30°C	86°F	0.995	0.995	0.995	0.994
40°C	104°F	0.984	0.984	0.983	0.982
50°C	122°F	0.973	0.972	0.971	0.969

L48		3000 LM	4000 LM	6000 LM	8000 LM	10000 LM	12000 LM
-30°C	-22°F	1.049	1.051	1.055	1.059	1.064	1.068
-20°C	-4°F	1.041	1.043	1.046	1.050	1.053	1.057
-10°C	14°F	1.033	1.034	1.037	1.040	1.042	1.046
0°C	32°F	1.024	1.025	1.027	1.029	1.031	1.033
10°C	50°F	1.015	1.015	1.017	1.018	1.019	1.020
20°C	68°F	1.005	1.005	1.006	1.006	1.006	1.007
25°C	77°F	1.000	1.000	1.000	1.000	1.000	1.000
30°C	86°F	0.995	0.995	0.994	0.994	0.993	0.993
40°C	104°F	0.984	0.983	0.982	0.981	0.980	0.978
50°C	122°F	0.972	0.971	0.969	0.967	0.965	0.963

L48		9000 LM	12000 LM	15000 LM	18000 LM	20000 LM	24000 LM
-30°C	-22°F	1.061	1.068	1.075	1.079	1.088	1.100
-20°C	-4°F	1.051	1.057	1.063	1.066	1.074	1.083
-10°C	14°F	1.041	1.045	1.050	1.052	1.058	1.066
0°C	32°F	1.030	1.033	1.036	1.038	1.042	1.048
10°C	50°F	1.018	1.020	1.022	1.023	1.026	1.029
20°C	68°F	1.006	1.007	1.008	1.008	1.009	1.010
25°C	77°F	1.000	1.000	1.000	1.000	1.000	1.000
30°C	86°F	0.994	0.993	0.992	0.992	0.991	0.990
40°C	104°F	0.980	0.978	0.976	0.975	0.973	0.969
50°C	122°F	0.967	0.963	0.960	0.958	0.954	0.948

LUMEN MAINTENANCE

Length	Lumens	0 Hrs	25000 Hrs	50000 Hrs	100000 Hrs
L24	2000	100%	92.8%	87.2%	77.0%
	3000	100%	92.8%	87.2%	77.0%
	4000	100%	92.6%	87.2%	77.1%
	6000	100%	93.0%	87.8%	78.3%

Length	Lumens	0 Hrs	25000 Hrs	50000 Hrs	100000 Hrs
L48	3000	100%	92.8%	87.2%	77.0%
	4000	100%	92.8%	87.2%	77.0%
	6000	100%	92.8%	87.2%	77.0%
	8000	100%	92.7%	87.2%	77.2%
	10000	100%	92.9%	87.5%	77.7%
	12000	100%	93.0%	87.8%	78.2%

Length	Lumens	0 Hrs	25000 Hrs	50000 Hrs	100000 Hrs
L96	9000	100%	92.8%	87.2%	77.0%
	12000	100%	92.8%	87.2%	77.0%
	15000	100%	92.6%	87.0%	76.9%
	18000	100%	92.6%	87.1%	77.1%
	20000	100%	92.8%	87.5%	77.7%
	24000	100%	92.9%	87.7%	78.1%

EMERGENCY LUMENS

		FEM		
Length	Lumens	BE6WCP	E7WRH	E10WMCP
L24	2000LM	X	1300	1800
	3000LM	X	1300	1800
	4000LM	X	1400	1900
	6000LM	X	1400	1900
L48	3000LM	1200	1400	1900
	4000LM	1200	1400	1900
	6000LM	1250	1450	2000
	8000LM	1250	1450	2000
	10000LM	1250	1450	2000
	12000LM	1250	1450	2000
L96	9000LM	1250	1450	2000
	12000LM	1400	1600	2200
	15000LM	1400	1600	2200
	18000LM	1400	1600	2200
	20000LM	1400	1600	2200
	24000LM	1400	1600	2200

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

CSA LISTED AMBIENT RATING

Size	Lumen Package	Base ‡		BE6WCP ‡		E10WLCP ‡		E7WR2H ‡	
		Surface	Suspended ‡	Surface	Suspended ‡	Surface	Suspended ‡	Surface	Suspended ‡
L24	2000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	3000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	4000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	6000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
L48	3000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	4000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	6000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	8000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	10000LM	35°C	45°C	25°C	35°C	25°C	35°C	25°C	25°C
	12000LM	35°C	35°C	25°C	35°C	25°C	35°C	25°C	25°C
L96	9000LM	35°C	50°C	25°C	35°C	25°C	35°C	25°C	25°C
	12000LM	35°C	35°C	25°C	35°C	25°C	35°C	25°C	25°C
	15000LM	35°C	35°C	25°C	35°C	25°C	35°C	25°C	25°C
	18000LM	35°C	35°C	25°C	35°C	25°C	35°C	25°C	25°C
	20000LM	35°C	35°C	25°C	35°C	25°C	35°C	25°C	25°C
	24000LM	30°C	35°C	25°C	35°C	25°C	35°C	25°C	25°C

Notes ‡	
Base	Start temp -40°C.
BE6WCP	Start temp -20°C.
E7W2H	Start temp 0°C.
E10WMCP	Start temp 5°C.
Suspended	Installed a minimum of 6" from surface.

NUMBER OF LED BOARDS & DRIVERS

Lumen Package	Fixture Length	Voltage	Number of LED Boards	Number of Drivers
2000LM	L24	Any	1	1
3000LM	L24	Any	1	1
4000LM	L24	Any	2	1
6000LM	L24	Any	2	1
3000LM	L48	Any	1	1
4000LM	L48	Any	1	1
6000LM	L48	Any	2	1
8000LM	L48	Any	2	1
10000LM	L48	Any	2	1
12000LM	L48	Any	2	1
9000LM	L96	Any	2	1
12000LM	L96	Any	4	1
15000LM	L96	Any	4	1
18000LM	L96	MVOLT 120-277	4	1
18000LM	L96	HVOLT 347-480	4	2
20000LM	L96	MVOLT 120-277	4	1
20000LM	L96	HVOLT 347-480	4	2
24000LM	L96	MVOLT 120-277	4	1
24000LM	L96	HVOLT 347-480	4	2

IK RATINGS

Type	Description	IK rating
IMAFL	Acrylic, lineal ribbed frosted lens	IK07
IMACD	Acrylic, clear deep lens	IK10
IMAFD	Acrylic, deep frosted lens	IK10
LPAFL	Acrylic, low profile frosted lens	IK10
LPACL	Acrylic, low profile clear lens	IK10
LPPCL	Polycarbonate, low profile clear lens	IK09
LPPFL	Polycarbonate, low profile frosted lens	IK09
Housing	FEM housing can withstand an IK10 level impact and not have any wires or electrical components exposed.	IK10

NEMA PLUG CONFIGURATIONS

Voltage	Straight Blade	15A Twist Lock	20A Twist Lock
MVOLT	NA	NA	NA
120	5-15P	L5-15P	L5-20P
208	NA	L6-15P	L6-20P
240	NA	L6-15P	L6-20P
277	7-15P	L7-15P	L7-20P
HVOLT	NA	NA	NA
347	NA	NA	L24-20P
480	NA	NA	L8-20P
XVOLT	NA	NA	NA
277X	NA	L7-15P	L7-20P
347X	NA	NA	L24-20P
480X	NA	NA	L8-20P

ADDITIONAL CORDSETS

Plug Option		Plug Type		Amperage		Gauge		# of conductors		Color		Location		Length	
CNP	Cord only	(blank)	No plug option (for cord only option)	(blank)	15 amps	16	16 gauge	(blank)	3 conductors	(blank)	Black	(blank)	Damp	(blank)	6 feet
CP	Cord with plug	TL	Twist lock	20A	20 amps			4C	4 conductors (for use with EM battery)	W	White	WL	Wet ‡	3FT	3 feet
CMC	Cord with mini change Plug ‡	SB	Straight blade ‡					5C	5 conductors (for use with ETS or ER controls)	Y	Yellow ‡			10FT	10 feet
MCR	Mini change receptacle	MBH	Male Brad Harrsion					5CD	5 conductors (for use with 0-10V dimming)					12FT	12 feet
														15FT	15 feet
														20FT	20 feet
														25FT	25 feet
														30FT	30 feet

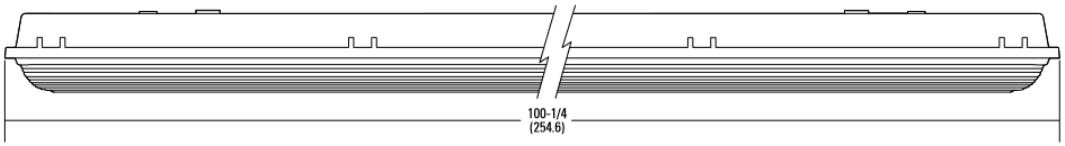
Notes ‡	
CMC	Available in 6ft or 12ft lengths only.
SB	Not available with WL.
WL	Not available with SB.
Y	Available with CMC or MCR only.

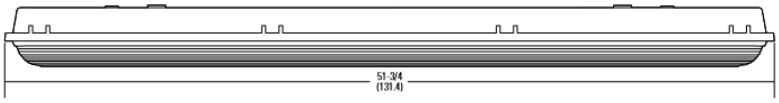
© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

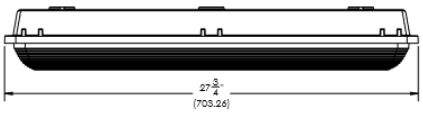
DIMENSIONS

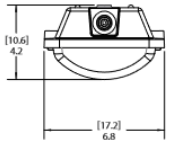
Specifications subject to change without notice.
All dimensions are inches (centimeters) unless otherwise indicated.

Weight (may vary with options or accessories)
FEM L48: 11.9 lbs (5.397kg)
FEM L96: 24.3 lbs (11.022kg)

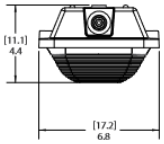




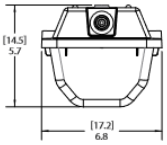




Diffuser Type:
LPAFL
LPACL
LPPFL
LPPCL

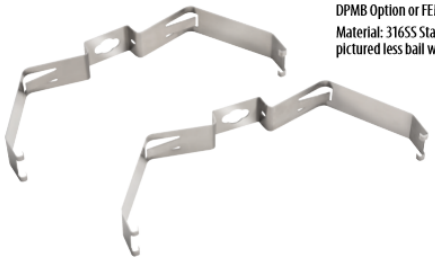


Diffuser Type:
IMAFL

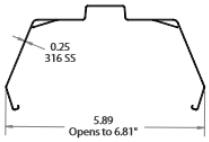


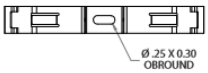
Diffuser Type:
IMAFD
IMACD

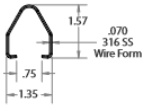
MOUNTING OPTIONS

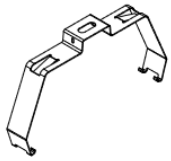


DPMB Option or FEMDPMB Accessory
Material: 316SS Stainless Steel
pictured less bail wire (316SS)









ACCESSORIES

CMCMBH16YWL, MCRMBH16WL
(actual product may vary depending on options chosen)

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

EMBEDDED LUMINAIRE TECHNOLOGY GUIDE

Control Type	Sensor Nomenclature	Sensor Used (click on part number to link to sensor spec sheet)		Out of the box settings: Unoccupied Time Until Dim/Off	Dim to Off Time Delay	Occupied Dim Level	Unoccupied Dim Level	Daylighting Set Point	Notes	Image
Sensor Switch Embedded Controls	SBOR6	SBOR 6 OEX EB3 WH		10M	n/a	100%	0V	n/a	360° High mount sensor, (15-30' mounting heights), outdoor PIR, on/off occupancy	
	SBOR6 D 3V	SBOR 6 OEX D EB3 WH 3V		10M	2.5M	100%	30%	n/a	360° High mount sensor, (15-30' mounting heights), outdoor PIR, occupancy controlled dimming	
	SBOR6 P	SBOR 6 OEX P EB3 WH		10M	n/a	100%	0V	5FC	360° High mount standalone embedded sensor (8-15'), outdoor PIR, on/off photocell	
	SBOR10	SBOR 10 OEX EB3 WH		10M	n/a	100%	0V	n/a	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, on/off occupancy	
	SBOR10 D 3V	SBOR 10 OEX D EB3 WH 3V		10M	2.5M	100%	30%	n/a	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, occupancy controlled dimming	
	SBOR10 P	SBOR 10 OEX P EB3 WH		10M	n/a	100%	0V	5FC	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, on/off photocell	
Sensor Switch Embedded Controls	SBOR6 ER	SBOR 6 OEX EB3 WH	ETS DR	10M	n/a	100%	0V	n/a	360° High mount sensor, (15-30' mounting heights), outdoor PIR, on/off occupancy, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	SBOR6 D 3V ER	SBOR 6 OEX D EB3 WH 3V	ETS DR	10M	2.5M	100%	30%	n/a	360° High mount sensor, (15-30' mounting heights), outdoor PIR, occupancy controlled dimming, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	SBOR6 P ER	SBOR 6 OEX P EB3 WH	ETS DR	10M	n/a	100%	0V	5FC	360° High mount standalone embedded sensor (8-15'), outdoor PIR, on/off photocell, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	SBOR10 ER	SBOR 10 OEX EB3 WH	ETS DR	10M	n/a	100%	0V	n/a	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, on/off occupancy, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	SBOR10 D 3V ER	SBOR 10 OEX D EB3 WH 3V	ETS DR	10M	2.5M	100%	30%	n/a	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, occupancy controlled dimming y, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	SBOR10 P ER	SBOR 10 OEX P EB3 WH	ETS DR	10M	n/a	100%	0V	5FC	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, on/off photocell, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
nLight Air Embedded Controls	NLTAIR2	RIO ZT 90D G2		n/a	n/a	80%	n/a	n/a	nLight® air embedded network interface, fully programmable with Clarity+ Pro app	
	NLTAIREM2	RIO ZT EM 90D G2		n/a	n/a	80%	n/a	n/a	nLight® air embedded network interface, fully programmable with Clarity+ Pro app, UL924 emergency operation, 3 conductor power input	
	NLTAIRER2	RIO ZT 90D G2	ETS DR	n/a	n/a	80%	n/a	n/a	nLight® air embedded network interface, fully programmable with Clarity+ Pro app, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	NLTAIR2 APIRKO	RSBOR 10 EB3 WH G2		7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° low mount sensor, (8-15' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app	
	NLTAIR2 APIRMKO	RSBOR 6 EB3 WH G2		7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° high mount sensor, (15-30' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app	
	NLTAIR2 APIRHKO	RSBOR 40 EB3 WH G2		7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° high mount site/area sensor, (40' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app	
	NLTAIREM2 APIRKO	RSBOR 10 EM EB3 WH G2		7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° low mount sensor, (8-15' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app, UL924 emergency operation, 3 conductor power input	
	NLTAIREM2 APIRMKO	RSBOR 6 EM EB3 WH G2		7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° high mount sensor, (15-30' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app, UL924 emergency operation, 3 conductor power input	
	NLTAIREM2 APIRHKO	RSBOR 40 EM EB3 WH G2		7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° high mount site/area sensor, (40' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app, UL924 emergency operation, 3 conductor power input	
	NLTAIRER2 APIRKO	RSBOR 10 EB3 WH G2	ETS DR	7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° low mount sensor, (8-15' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	NLTAIRER2 APIRMKO	RSBOR 6 EB3 WH G2	ETS DR	7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° high mount sensor, (15-30' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app, UL924 emergency operation, includes IOTA ETS DR, 5 conductor power input	
	NLTAIRER2 APIRHKO	RSBOR 40 EB3 WH G2	ETS DR	7.5M	2.5M	100%	10%	50FC	nLight® air generation 2 360° high mount site/area sensor, (40' heights), combined daylight and occupancy dimming, fully programmable with Clarity+ Pro app, UL924 emergency operation, 3 conductor power input	

© 2012-2025 Acuity Brands Lighting, Inc. All rights reserved.

EQUIPMENT

MANUFACTURER	Sightline
CATALOG NUMBER	LSRL-30-30-FR-A/S-16-AL
TOTAL WATTS	96
VOLTAGE	110-277
MOUNTING	Wall
WEIGHT	
DIMENSIONS	
FINISH	TBD
RATING	IP65
LISTING	UL

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	300 lm/ft
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

Wall mount fixed mid-rail light with one (1) LED lighting source, 300 lm/ft delivered lumens, 3000K color engine, 80+ CRI, 110° optic and remote driver. Mid-rail Light should operate on 110-277 voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Mid-rail light to have tbd finish. Mid-rail Light to be rated for IP65 or equivalent. Mid-rail Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Illuminated rail to be in the mid rail location. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

SINGLE COLOR - STRIP LIGHT RAIL

Powered by Q-tran® LED

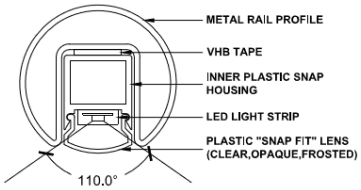
PART NUMBERS

LSRL	-	30	-	30	-	FR	-	A/S	-	16	-	AL
SERIES		WATTS/FT		COLOR TEMP		LENS		SYMMETRY		SIZE		MATERIAL
		30 = 3.0 W/FT 40 = 4.0 W/FT		27 = 2700K 30 = 3000K 35 = 3500K 40 = 4000K AM = AMBER (WILDLIFE CERT)		CL = CLEAR OP = OPAQUE FR = FROSTED		S = SYMMETRIC A = ASYMMETRIC (45° NADIR)		15 = 1.5" OD 16 = 1.66" OD 19 = 1.90" OD		AL = ALUMINUM SS = STAINLESS

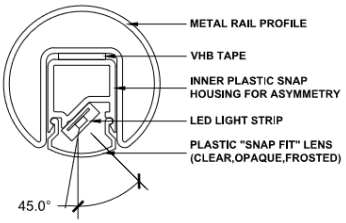
FEATURES & SPECIFICATIONS

- INPUT VOLTAGE: 24 VDC
- BEAM ANGLE: 110°
- DIMMABLE: YES
- CUTLENGTH INCREMENTS: 1"
- LEDS PER FOOT: 75
- TEMP RANGE: -40° - 140° F
- IP RATING: IP67
- CRI Ra: 95+
- OPAQUE LENS OPACITY: 30%
- FROSTED LENS OPACITY: 10%
- FOR USE AS HANDRAIL OR GUARD TOP RAIL.
- FINISHES:
  - ALUMINUM: CLEAR ANODIZE
  - STAINLESS: #4 SATIN
- 3.0 W/FT LENGTHS: 1" - 360"
- 4.0 W/FT LENGTHS: 1" - 288"
- 5.0 W/FT LENGTHS: 1" - 228"
- EST. LED LIFE: 70,000 HRS (L70)
- WARRANTY: 5 YEARS
- LISTINGS:

HANDRAIL/ GUARDRAIL WITH SYMMETRIC LENS - SECTION DETAIL



HANDRAIL/ GUARDRAIL WITH ASYMMETRIC LENS - SECTION DETAIL



ALL DATA +/- 10% TOLERANCE

ITEM	DESCRIPTION	AUTH	DATE

SIGHTLINE COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094

THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.

LED RAILING
SINGLE COLOR STRIP LIGHTS
PRODUCT TECHNICAL SPECIFICATIONS

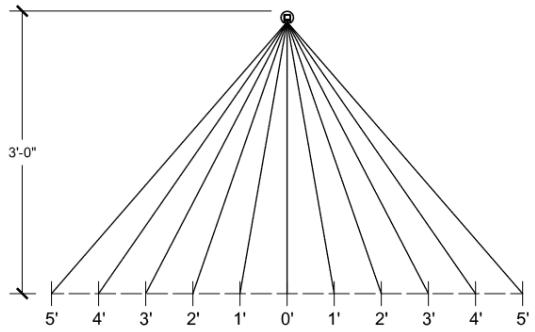
DRAWN BY	DATE
NBB	11/1/20

PROJECT NAME: LED
DWG. NUMBER: LED-STRIP-SPEC-1

SINGLE COLOR - STRIP LIGHT RAIL

Powered by Q-tran® LED

LED LIGHT DISPERSION TABLES
SYMMETRICAL
All Values in Foot-Candle (FC) ±15%



3.0 W/FT - SPECS (OPAQUE LENS)								
	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION					
COLOR			0'	1'	2'	3'	4'	5'
2700K	177	97	30.1	25.2	16.2	9.0	5.1	3.0
3000K	173	98	28.2	23.7	15.4	8.9	5.1	3.1
3500K	190	98	31.0	26.2	17.0	9.6	6.4	3.3
4000K	179	97	28.7	24.2	15.7	9.1	5.2	3.2

3.0 W/FT - SPECS (FROSTED LENS)								
	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION					
COLOR			0'	1'	2'	3'	4'	5'
2700K	196	97	40.0	31.5	17.5	8.8	4.3	1.5
3000K	202	98	42.3	33.3	18.3	9.0	4.5	2.4
3500K	209	98	42.2	33.5	18.7	9.4	4.9	2.7
4000K	210	98	42.0	33.5	18.9	9.6	5.0	2.8

4.0 W/FT - SPECS (OPAQUE LENS)								
	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION					
COLOR			0'	1'	2'	3'	4'	5'
2700K	213	97	36.2	30.3	19.3	10.7	5.9	3.5
3000K	210	97	36.3	30.4	19.2	10.6	5.9	3.5
3500K	242	98	39.9	33.6	21.7	12.4	7.2	4.3
4000K	220	97	36.7	30.7	19.6	11.2	6.4	3.9

4.0 W/FT - SPECS (FROSTED LENS)								
	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION					
COLOR			0'	1'	2'	3'	4'	5'
2700K	238	97	48.4	38.3	21.3	10.8	5.6	3.1
3000K	252	98	51.3	41.0	22.9	11.5	5.9	3.3
3500K	273	98	50.0	40.8	24.7	13.4	7.3	4.2
4000K	256	98	54.3	42.4	23.1	11.3	5.7	3.1

ALL DATA +/- 10% TOLERANCE
DATA LISTED IS FOR 3'-0" HANDRAIL HEIGHT, CONTACT SIGHTLINE COMMERCIAL SOLUTIONS FOR 3'-6" DATA.

ITEM	DESCRIPTION	AUTH	DATE

SIGHTLINE COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094

THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.

LED RAILING
SINGLE COLOR STRIP LIGHTS
PRODUCT TECHNICAL SPECIFICATIONS

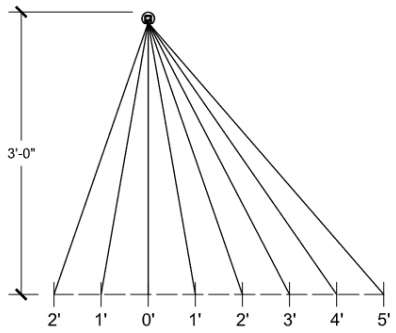
DRAWN BY	DATE
NBB	11/1/20

PROJECT NAME: LED
DWG. NUMBER: LED-STRIP-SPEC-2

SINGLE COLOR - STRIP LIGHT RAIL

Powered by Q-tran® LED

LED LIGHT DISPERSION TABLES
ASYMMETRICAL
All Values in Foot-Candle (FC) ±15%



3.0 W/FT - SPECS (OPAQUE LENS)

COLOR	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION							
			-2'	-1'	0'	1'	2'	3'	4'	5'
2700K	140	97	11.6	18.7	23.2	20.5	13.6	7.9	4.5	2.7
3000K	132	97	10.5	17.4	22.6	20.7	14.2	7.8	4.3	2.5
3500K	156	97	12.6	20.4	25.7	22.8	15.5	9.3	5.4	3.2
4000K	156	97	13.1	21.1	26.3	22.8	15.1	8.8	5.0	3.0

3.0 W/FT - SPECS (FROSTED LENS)

COLOR	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION							
			-2'	-1'	0'	1'	2'	3'	4'	5'
2700K	164	98	13.2	24.5	33.5	29.0	16.8	8.3	4.1	2.2
3000K	148	98	11.3	20.3	28.2	25.7	16.3	8.6	4.4	2.4
3500K	180	98	14.4	25.2	33.6	29.8	18.9	10.2	5.4	2.9
4000K	177	97	15.2	26.0	33.9	28.7	17.1	8.6	4.3	2.3

4.0 W/FT - SPECS OPAQUE LENS)

COLOR	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION							
			-2'	-1'	0'	1'	2'	3'	4'	5'
2700K	176	97	15.1	24.6	30.8	26.8	17.3	9.2	4.9	2.9
3000K	202	97	12.9	20.6	25.3	22.0	13.9	7.9	4.6	2.8
3500K	185	98	15.4	25.1	31.6	28.4	18.8	10.5	5.8	3.4
4000K	204	97	17.8	27.8	33.7	29.0	18.8	10.7	6.0	3.5

4.0 W/FT - SPECS (FROSTED LENS)

COLOR	LUMEN/FT	CRI Ra	FOOT-CANDLE DISPERSION							
			-2'	-1'	0'	1'	2'	3'	4'	5'
2700K	188	97	15.2	28.1	38.2	32.8	18.7	9.1	4.6	2.4
3000K	229	98	19.9	33.3	42.2	35.8	22.0	11.6	6.0	3.2
3500K	211	98	17.9	32.4	43.7	36.2	19.7	9.2	4.4	2.3
4000K	227	98	17.6	32.1	44.3	39.1	23.9	12.5	6.6	3.6

ALL DATA +/- 10% TOLERANCE
DATA LISTED IS FOR 3'-0" HANDRAIL HEIGHT, CONTACT SIGHTLINE COMMERCIAL SOLUTIONS FOR 3'-6" DATA.

ITEM	DESCRIPTION	AUTH	DATE

SIGHTLINE COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094

THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.

LED RAILING
SINGLE COLOR STRIP LIGHTS
PRODUCT TECHNICAL SPECIFICATIONS

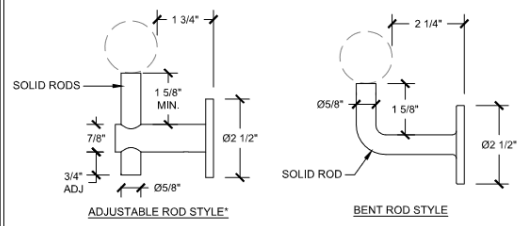
DRAWN BY	DATE
NBB	11/1/20

PROJECT NAME: LED
DWG. NUMBER: LED-STRIP-SPEC-3

SINGLE COLOR - STRIP LIGHT RAIL

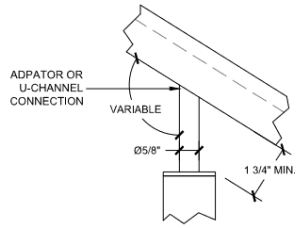
HANDRAIL/GUARDRAIL SYSTEM DETAILS

**HANDRAIL BRACKETS

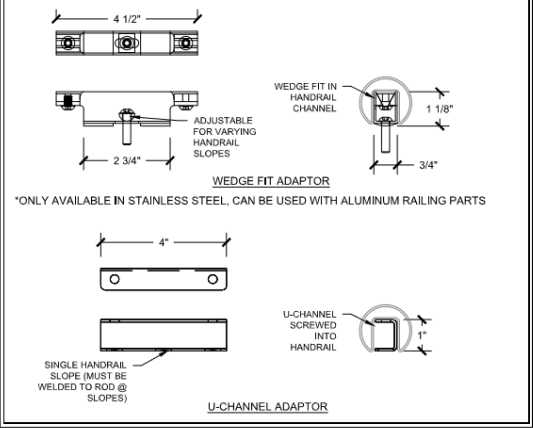


*ADJUSTABLE STYLE ONLY AVAILBLE IN STAINLESS STEEL
**HANDRAIL BRACKETS SHOWN AS WALL MOUNT. GLASS & POST MOUNT ALSO AVAILABLE

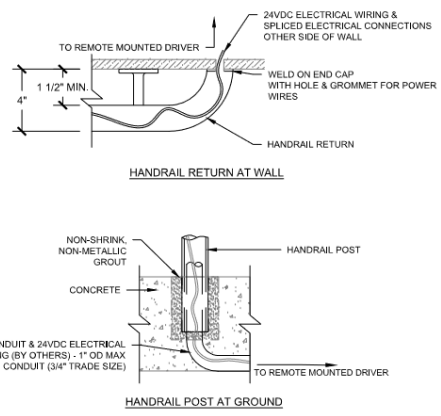
POST TOP BRACKET



HANDRAIL BRACKET CONNECTORS



POWER ROUTING DETAILS



ITEM	DESCRIPTION	AUTH	DATE

SIGHTLINE COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094

THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.

LED RAILING
SINGLE COLOR STRIP LIGHTS
PRODUCT TECHNICAL SPECIFICATIONS

DRAWN BY	DATE
NBB	11/1/20

PROJECT NAME: LED
DWG. NUMBER: LED-STRIP-SPEC-4

REMOTE VAULT POWER SUPPLY

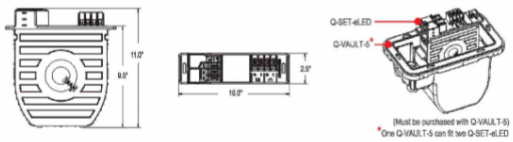
Powered by Q-tran® LED

PART NUMBERS

Q-SET-eLED	-	sizing will depend on location	-	UNV	-	24VDC	-	0-10V
SERIES		SIZE		INPUT VOLTAGE		OUTPUT VOLTAGE		DIMMING
		100 = 100W 200 = 100W X 2		UNV = 110-277V		24VDC = 24 VOLTS		0-10v = DIMMING N/A = NO DIMMING

FEATURES

- MUST BE PURCHASED WITH A Q-VAULT-5 HOUSING
- DIMENSIONS: 11.0"L x 10.0"W x 2.5"D
- CONSTANT VOLTAGE OUTPUT
- DIMMABLE WITH ADDITIONAL 0-10V DIMMING MODULE:
- LIMITED OUTPUT VOLTAGE AND CURRENT, PLUS ISOLATION SAFE OPERATION
- FULLY POTTED DRIVER(S) FOR MOISTURE RESISTANCE
- IP 68 RATING DIRECT BURIAL WITH Q-VAULT-5 ENCLOSURE
- SUITABLE FOR DRY, DAMP AND WET LOCATIONS
- SUITABLE FOR OUTDOOR USE
- CLASS 2 OUTPUT
- WARRANTY: 5 YEARS
- EMI/RFI COMPLIANT TO FCC 47 PART 15B, CISPR15, & CISPR 22 CLASS A
- UL LISTED (UL1838, UL2108)
- CSA #239924



SPECIFICATIONS

INPUT			
• INPUT VOLTAGE (Vrms)	120-277		
• INPUT CURRENT, MAX (Arms)	0.98A @ 120V		
• INRUSH CURRENT, MAX (Apk)	45A @ 120V		
• INPUT FREQUENCY (Hz)	50/60		
• INPUT POWER (W)	177		
OUTPUT			
• OUTPUT VOLTAGE, NOM (VDC)	24		
• OUTPUT CURRENT (A)	100W 4.1A @ 24V 200W, 2X4.1A @ 24V		
• OUTPUT POWER (Wmax)	100W 200W (2X100)		
ENVIRONMENTAL	**MIN**	**NOM**	**MAX**
• THD (%)	--	---	20
• PF (%)	0.90	---	---
• WORKING TEMP (°F)	4	---	104
PROTECTIONS			
• SHORT CURCUIT PROTECTION			
• OVER LOADING PROTECTION			

ITEM	DESCRIPTION	AUTH	DATE

SIGHTLINE COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094

THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.

LED RAILING
VAULT POWER SUPPLIES
PRODUCT TECHNICAL SPECIFICATIONS

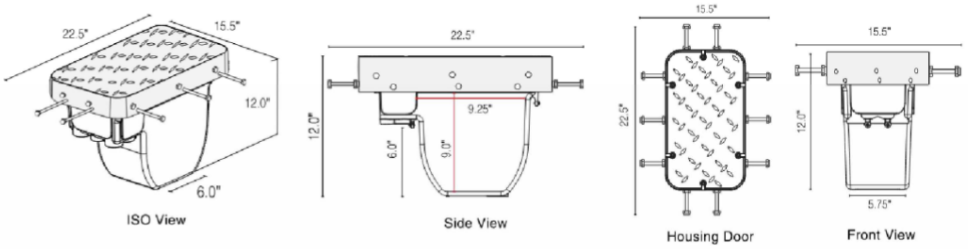
DRAWN BY	DATE
NBB	11/1/20

PROJECT NAME: LED
DWG. NUMBER: LED-VAULT-SPEC-1

REMOTE VAULT POWER SUPPLIES

Powered by Q-tran® LED

Q-VAULT-5



POWER SUPPLY MAX FEED LENGTH		
	100W	200W
3.0 W/FT STRIP	25 FT	2 x 25 FT
4.0 W/FT STRIP	19 FT	2 x 19 FT
5.0 W/FT STRIP	15 FT	2 x 15 FT
PODS/CIRCUIT @ 2' OC*	37 PODS	2 x 37 PODS
PODS/CIRCUIT @ 4' OC*	36 PODS	2 x 36 PODS

* BASED ON 16 AWG WIRING BETWEEN PODS - INCREASED SPACING REDUCES NUMBER OF PODS PER CIRCUIT

FEATURES

- FOR USE WITH Q-SET-eLED POWER SUPPLIES ONLY
- FITSUP TO (2X) Q-SETs
- STAINLESS STEEL COVER
- STAINLESS STEEL LAWN GUARD / CONCRETE POUR RING
- IP 68 RATED
- SUITABLE FOR INGROUND, DIRECT BURIAL, OUTDOOR APPLICATIONS
- WARRANTY: 5 YEARS
- CSA LISTED (UL1838, UL2108)

DISTANCE POWER SUPPLY TO FIRST LED
(3% VOLTAGE DROP)

STRIP LED	LOAD - TOTAL WATTS			
WIRE GAUGE	50W 2.1A	60W 2.5A	70W 2.9A	76W 3.2A
20 AWG	15 ft	15 ft	10 ft	10 ft
18 AWG	25 ft	20 ft	20 ft	17 ft
16 AWG	40 ft	35 ft	30 ft	28 ft
14 AWG	65 ft	55 ft	45 ft	45 ft
12 AWG	105 ft	90 ft	75 ft	70 ft
10 AWG	170 ft	140 ft	120 ft	110 ft

* USABLE WATTAGE OF DRIVER IS 80% OF MAX VALUE. IE. 80% * 96WATTS = 76 WATTS

1) CALCULATE TOTAL LOAD: Multiply the strip light part nominal power consumption (watts/ft) from table on page 1 by the total length of light to be connected to the power supply. Example: 1.46 watts/ft * 30 ft = 43.8 watts.
2) FIND THE COLUMN WITH APPLICABLE LOAD: Find LOAD column associated with the calculated load. Round up if between two loads. Example: 43.8 watts - look at 50W/2.1A load column.
3) FIND DISTANCE FROM DRIVER TO LOAD: Within the LOAD column, find the appropriate distance from power supply to first LED strip light.
4) CHOOSE WIRE GAUGE: Follow the row the far left of the table for the listed wire gauge.

POD LED	LOAD - # OF PODS			
WIRE GAUGE	25	30	35	37
20 AWG	15 ft	13 ft	12 ft	10 ft
18 AWG	25 ft	20 ft	15 ft	15 ft
16 AWG	40 ft	35 ft	30 ft	25 ft
14 AWG	65 ft	55 ft	45 ft	45 ft
12 AWG	105 ft	85 ft	75 ft	70 ft
10 AWG	165 ft	140 ft	120 ft	115 ft

* BASED ON 16 AWG WIRING BETWEEN PODS, 2FT SPACING, & 96 W DRIVER - INCREASE POD SPACING CHANGES REQUIREMENTS.

1) FIND THE COLUMN WITH APPLICABLE LOAD: Find LOAD - # OF PODS column associated with the project requirements. Round up if between two loads. Example: 23 pods - look at 25 POD load column.
2) FIND DISTANCE FROM DRIVER TO LOAD: Within the LOAD (# OF PODS) column, find the appropriate distance from power supply to first LED POD.
3) CHOOSE WIRE GAUGE: Follow the row to far left of the table for the listed wire gauge.

*TABLES PROVIDE GENERAL GUIDELINES FOR DETERMINING WIRE GAUGE BASED ON TOTAL LOAD AND DISTANCE FROM LED DRIVER TO BEGINNING OF LUMINAIRE. ALWAYS CONSULT A QUALIFIED ELECTRICIAN BEFORE WIRING. LOW VOLTAGE STRANDED-INSULATED COPPER WIRE RATED FOR IN WALL USE IS RECOMMENDED.

-120VAC WIRE SIZING, CONNECTION TO MAIN POWER, AND ALL DRIVER CONNECTIONS TO BE PERFORMED BY A QUALIFIED ELECTRICIAN. ALWAYS VERIFY MAIN POWER IS SHUT OFF BEFORE PERFORMING ANY WORK ON ELECTRICAL COMPONENTS.

ITEM	DESCRIPTION	AUTH	DATE

SIGHTLINE COMMERCIAL SOLUTIONS

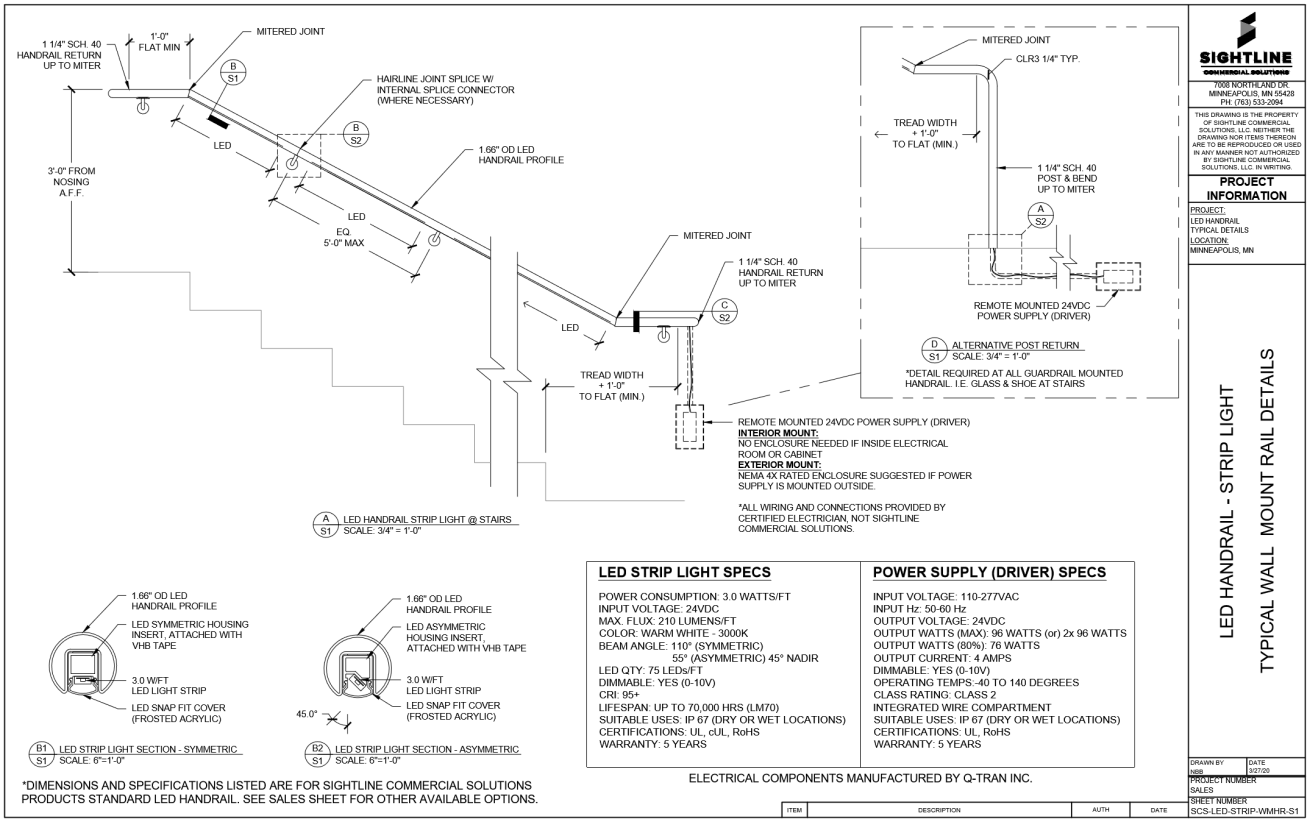
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094

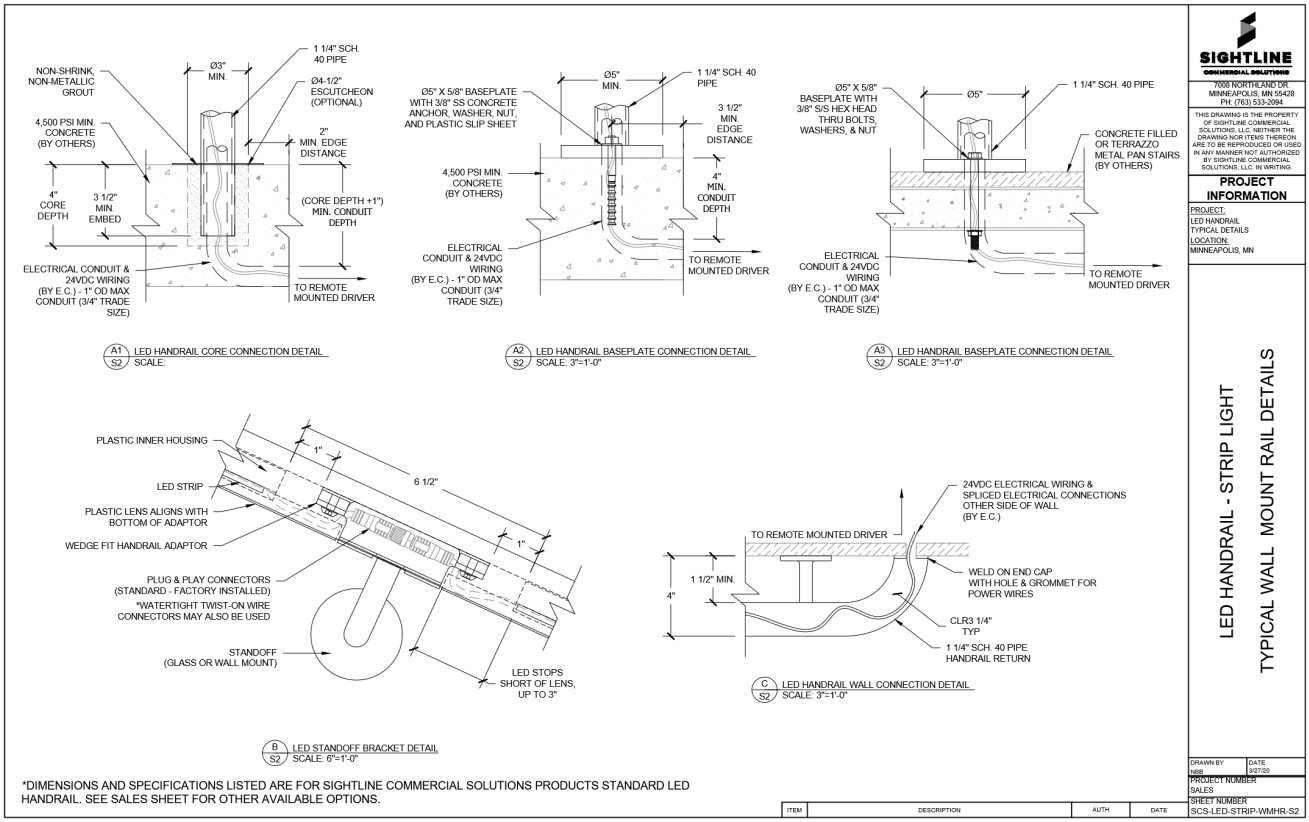
THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.

LED RAILING
VAULT POWER SUPPLY
PRODUCT TECHNICAL SPECIFICATIONS

DRAWN BY	DATE
NBB	11/1/20

PROJECT NAME: LED
DWG. NUMBER: LED-VAULT-SPEC-2


1 1/4" SCH. 40 HANDRAIL RETURN UP TO MITER
1'-0" FLAT MIN
MITERED JOINT
B S1
HAIRLINE JOINT SPLICE W/ INTERNAL SPLICE CONNECTOR (WHERE NECESSARY)
B S2
LED
1.66" OD LED HANDRAIL PROFILE
3'-0" FROM NOSING A.F.F.
LED
EQ. 5'-0" MAX
MITERED JOINT
1 1/4" SCH. 40 HANDRAIL RETURN UP TO MITER
C S2
LED
TREAD WIDTH + 1'-0" TO FLAT (MIN.)
REMOTE MOUNTED 24VDC POWER SUPPLY (DRIVER)
INTERIOR MOUNT:
NO ENCLOSURE NEEDED IF INSIDE ELECTRICAL ROOM OR CABINET
EXTERIOR MOUNT:
NEMA 4X RATED ENCLOSURE SUGGESTED IF POWER SUPPLY IS MOUNTED OUTSIDE.
*ALL WIRING AND CONNECTIONS PROVIDED BY CERTIFIED ELECTRICIAN, NOT SIGHTLINE COMMERCIAL SOLUTIONS.
A S1 LED HANDRAIL STRIP LIGHT @ STAIRS
SCALE: 3/4" = 1'-0"
MITERED JOINT
CLR3 1/4" TYP.
TREAD WIDTH + 1'-0" TO FLAT (MIN.)
1 1/4" SCH. 40 POST & BEND UP TO MITER
A S2
REMOTE MOUNTED 24VDC POWER SUPPLY (DRIVER)
D S1 ALTERNATIVE POST RETURN
SCALE: 3/4" = 1'-0"
*DETAIL REQUIRED AT ALL GUARDRAIL MOUNTED HANDRAIL. I.E. GLASS & SHOE AT STAIRS
1.66" OD LED HANDRAIL PROFILE
LED SYMMETRIC HOUSING INSERT, ATTACHED WITH VHB TAPE
3.0 W/FT LED LIGHT STRIP
LED SNAP FIT COVER (FROSTED ACRYLIC)
B1 S1 LED STRIP LIGHT SECTION - SYMMETRIC
SCALE: 6"=1'-0"
1.66" OD LED HANDRAIL PROFILE
LED ASYMMETRIC HOUSING INSERT, ATTACHED WITH VHB TAPE
3.0 W/FT LED LIGHT STRIP
LED SNAP FIT COVER (FROSTED ACRYLIC)
45.0°
B2 S1 LED STRIP LIGHT SECTION - ASYMMETRIC
SCALE: 6"=1'-0"
LED STRIP LIGHT SPECS
POWER CONSUMPTION: 3.0 WATTS/FT
INPUT VOLTAGE: 24VDC
MAX. FLUX: 210 LUMENS/FT
COLOR: WARM WHITE - 3000K
BEAM ANGLE: 110° (SYMMETRIC)
55° (ASYMMETRIC) 45° NADIR
LED QTY: 75 LEDs/FT
DIMMABLE: YES (0-10V)
CRI: 95+
LIFESPAN: UP TO 70,000 HRS (LM70)
SUITABLE USES: IP 67 (DRY OR WET LOCATIONS)
CERTIFICATIONS: UL, cUL, RoHS
WARRANTY: 5 YEARS
POWER SUPPLY (DRIVER) SPECS
INPUT VOLTAGE: 110-277VAC
INPUT Hz: 50-60 Hz
OUTPUT VOLTAGE: 24VDC
OUTPUT WATTS (MAX): 96 WATTS (or) 2x 96 WATTS
OUTPUT WATTS (80%): 76 WATTS
OUTPUT CURRENT: 4 AMPS
DIMMABLE: YES (0-10V)
OPERATING TEMPS: -40 TO 140 DEGREES
CLASS RATING: CLASS 2
INTEGRATED WIRE COMPARTMENT
SUITABLE USES: IP 67 (DRY OR WET LOCATIONS)
CERTIFICATIONS: UL, RoHS
WARRANTY: 5 YEARS
ELECTRICAL COMPONENTS MANUFACTURED BY Q-TRAN INC.
*DIMENSIONS AND SPECIFICATIONS LISTED ARE FOR SIGHTLINE COMMERCIAL SOLUTIONS PRODUCTS STANDARD LED HANDRAIL. SEE SALES SHEET FOR OTHER AVAILABLE OPTIONS.
ITEM
DESCRIPTION
AUTH
DATE
SIGHTLINE
COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094
THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.
PROJECT INFORMATION
PROJECT:
LED HANDRAIL TYPICAL DETAILS
LOCATION:
MINNEAPOLIS, MN
LED HANDRAIL - STRIP LIGHT
TYPICAL WALL MOUNT RAIL DETAILS
DRAWN BY
NBB
DATE
3/27/20
PROJECT NUMBER
SALES
SHEET NUMBER
SCS-LED-STRIP-WMHR-S1


NON-SHRINK, NON-METALLIC GROUT
4,500 PSI MIN. CONCRETE (BY OTHERS)
4" CORE DEPTH
3 1/2" MIN. EMBED
Ø3" MIN.
1 1/4" SCH. 40 PIPE
Ø4-1/2" ESCUTCHEON (OPTIONAL)
2" MIN. EDGE DISTANCE
(CORE DEPTH +1") MIN. CONDUIT DEPTH
ELECTRICAL CONDUIT & 24VDC WIRING (BY E.C.) - 1" OD MAX CONDUIT (3/4" TRADE SIZE)
TO REMOTE MOUNTED DRIVER
A1 S2 LED HANDRAIL CORE CONNECTION DETAIL
SCALE:
Ø5" X 5/8" BASEPLATE WITH 3/8" SS CONCRETE ANCHOR, WASHER, NUT, AND PLASTIC SLIP SHEET
Ø5" MIN.
1 1/4" SCH. 40 PIPE
3 1/2" MIN. EDGE DISTANCE
4,500 PSI MIN. CONCRETE (BY OTHERS)
4" MIN. CONDUIT DEPTH
ELECTRICAL CONDUIT & 24VDC WIRING (BY E.C.) - 1" OD MAX CONDUIT (3/4" TRADE SIZE)
TO REMOTE MOUNTED DRIVER
A2 S2 LED HANDRAIL BASEPLATE CONNECTION DETAIL
SCALE: 3"=1'-0"
Ø5" X 5/8" BASEPLATE WITH 3/8" S/S HEX HEAD THRU BOLTS, WASHERS, & NUT
Ø5"
1 1/4" SCH. 40 PIPE
CONCRETE FILLED OR TERRAZZO METAL PAN STAIRS (BY OTHERS)
ELECTRICAL CONDUIT & 24VDC WIRING (BY E.C.) - 1" OD MAX CONDUIT (3/4" TRADE SIZE)
TO REMOTE MOUNTED DRIVER
A3 S2 LED HANDRAIL BASEPLATE CONNECTION DETAIL
SCALE: 3"=1'-0"
PLASTIC INNER HOUSING
LED STRIP
PLASTIC LENS ALIGNS WITH BOTTOM OF ADAPTOR
WEDGE FIT HANDRAIL ADAPTOR
PLUG & PLAY CONNECTORS (STANDARD - FACTORY INSTALLED)
*WATERTIGHT TWIST-ON WIRE CONNECTORS MAY ALSO BE USED
STANDOFF (GLASS OR WALL MOUNT)
1"
6 1/2"
1"
LED STOPS SHORT OF LENS, UP TO 3"
B S2 LED STANDOFF BRACKET DETAIL
SCALE: 6"=1'-0"
TO REMOTE MOUNTED DRIVER
1 1/2" MIN.
4"
24VDC ELECTRICAL WIRING & SPLICED ELECTRICAL CONNECTIONS OTHER SIDE OF WALL (BY E.C.)
WELD ON END CAP WITH HOLE & GROMMET FOR POWER WIRES
CLR3 1/4" TYP
1 1/4" SCH. 40 PIPE HANDRAIL RETURN
C S2 LED HANDRAIL WALL CONNECTION DETAIL
SCALE: 3"=1'-0"
*DIMENSIONS AND SPECIFICATIONS LISTED ARE FOR SIGHTLINE COMMERCIAL SOLUTIONS PRODUCTS STANDARD LED HANDRAIL. SEE SALES SHEET FOR OTHER AVAILABLE OPTIONS.
ITEM
DESCRIPTION
AUTH
DATE
SIGHTLINE COMMERCIAL SOLUTIONS
7008 NORTHLAND DR.
MINNEAPOLIS, MN 55428
PH: (763) 533-2094
THIS DRAWING IS THE PROPERTY OF SIGHTLINE COMMERCIAL SOLUTIONS, LLC. NEITHER THE DRAWING NOR ITEMS THEREON ARE TO BE REPRODUCED OR USED IN ANY MANNER NOT AUTHORIZED BY SIGHTLINE COMMERCIAL SOLUTIONS, LLC. IN WRITING.
PROJECT INFORMATION
PROJECT:
LED HANDRAIL
TYPICAL DETAILS
LOCATION:
MINNEAPOLIS, MN
LED HANDRAIL - STRIP LIGHT
TYPICAL WALL MOUNT RAIL DETAILS
DRAWN BY
NBB
DATE
3/27/20
PROJECT NUMBER
SALES
SHEET NUMBER
SCS-LED-STRIP-WMHR-S2

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	WP-RGB-CC4040MR-84-10-10m
TOTAL WATTS	96
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	LENGTH x .47" x .08"
FINISH	White
RATING	IP20
LISTING	UL

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGB
CRI	
LUMEN OUTPUT	37/99/18
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

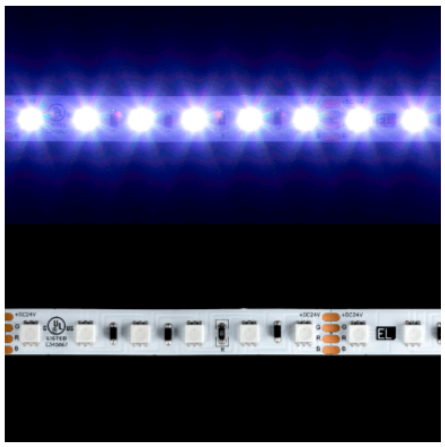
Surface mount fixed tape light with one (1) LED lighting source, 37/99/18 delivered lumens, RGB color engine, 120° optic and remote driver. Tape Light should operate on 120 voltage and be supplied with a dmx control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Tape light to have white finish. Tape Light to be rated for IP20 or equivalent. Tape Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

See plans for exact lengths. Fixture mounting conditions to be confirmed prior to procurement. Extrusion to be confirmed with Millwork before ordering. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.



MaxRun RGB 4040 LED Strip Light - 84/m - 10m Reel

Environmental Lights | cULus LISTED | Color Change | RoHS Compliant

Product Number: RGB-CC4040MR-84-10-10m

Call us at 866-343-2908 or Contact Us to set up your corporate account.

Specifications

Ambient Temperature	-20°C to 45°C
Brightness	120/325/60 lumens/meter
Brightness 2	610/685/1040mW/meter
Country of Origin	China
Height (English)	0.08 in
Height (Metric)	2 mm
Input Current	5000 mA
IP Rating	IP20
LED Density	84 LEDs/meter
LED Node Size	4040
LED Spacing (English)	0.47 in
LED Spacing (Metric)	11.9 mm
Length (English)	32.81 ft
Length (Metric)	10 m
Light Color	RGB
Light Color Detail	Red, Green, Blue
Manufacturer	Environmental Lights
Min. Cutting Increment (English)	2.81 in
Min. Cutting Increment (Metric)	71.4 mm
Rating	UL, RoHS
Beam Angle	120°
Input Voltage	24 DC
Warranty	5 years limited
Power (Watts)	120
Power (Watts/ft)	3.7
Power (Watts/m)	12
Wavelength	630/515/460
Width (English)	0.39 in
Width (Metric)	10 mm

Privacy - Terms

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	RGB-CC4040MR-84-10-10m
TOTAL WATTS	96
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	LENGTH x .47" x .08"
FINISH	White
RATING	IP20
LISTING	UL

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGB
CRI	
LUMEN OUTPUT	37/99/18
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

TYPE	Channel System
MANUFACTURER	Klus
CATALOG NUMBER	CS124

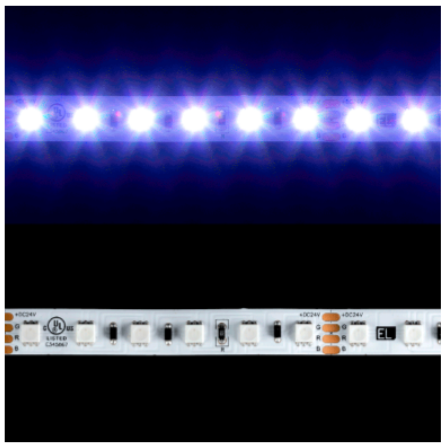
Surface mount fixed tape light with one (1) LED lighting source, 37/99/18 delivered lumens, RGB color engine, 120° optic and remote driver. Tape Light should operate on 120 voltage and be supplied with a dmx control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Tape light to have white finish. Tape Light to be rated for IP20 or equivalent. Tape Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

See plans for exact lengths. Fixture mounting conditions to be confirmed prior to procurement. Extrusion to be confirmed with Millwork before ordering. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.



MaxRun RGB 4040 LED Strip Light - 84/m - 10m Reel

Environmental Lights · cULus LISTED · Color Change · RoHS Compliant

Product Number: RGB-CC4040MR-84-10-10m

Call us at 866-343-2908 or Contact Us to set up your corporate account.

Specifications

Ambient Temperature	-20°C to 45°C
Brightness	120/325/60 lumens/meter
Brightness 2	610/685/1040mW/meter
Country of Origin	China
Height (English)	0.08 in
Height (Metric)	2 mm
Input Current	5000 mA
IP Rating	IP20
LED Density	84 LEDs/meter
LED Node Size	4040
LED Spacing (English)	0.47 in
LED Spacing (Metric)	11.9 mm
Length (English)	32.81 ft
Length (Metric)	10 m
Light Color	RGB
Light Color Detail	Red, Green, Blue
Manufacturer	Environmental Lights
Min. Cutting Increment (English)	2.81 in
Min. Cutting Increment (Metric)	71.4 mm
Rating	UL, RoHS
Beam Angle	120°
Input Voltage	24 DC
Warranty	5 years limited
Power (Watts)	120
Power (Watts/ft)	3.7
Power (Watts/m)	12
Wavelength	630/515/460
Width (English)	0.39 in
Width (Metric)	10 mm

Privacy - Terms

CS124 LED Channel System Including Base Klus-B1718K7-2m and Top Klus-1369-2m

KLUŚ

Product Number: CS124

Call us at 866-343-2908 or Contact Us to set up your corporate account.

Specifications

Country of Origin	Poland
Inside Width	11 mm
Height (English)	0.39 in
Height (Metric)	10 mm
Length (English)	78.74 in
Length (Metric)	2 m
Manufacturer	Klus
Width (English)	0.63 in
Width (Metric)	16 mm

Privacy - Terms

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	WP-3000K-2216MR-240-10-REEL
TOTAL WATTS	2.2
VOLTAGE	24VDC
MOUNTING	Surface
WEIGHT	
DIMENSIONS	LENGTH x .39" x .19"
FINISH	
RATING	IP65
LISTING	RoHS

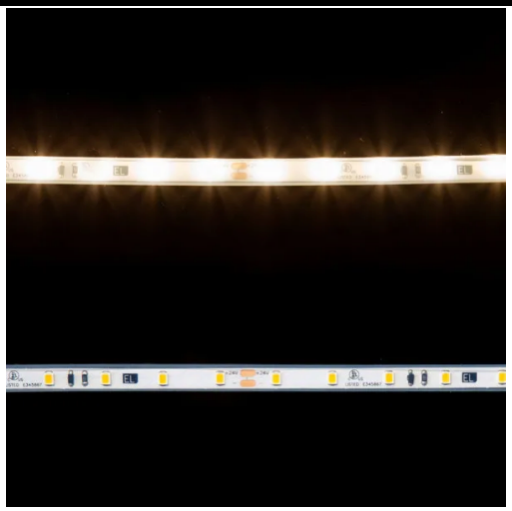
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	
LUMEN OUTPUT	204lm/ft
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES



Surface mount fixed tape light with one (1) LED lighting source, 204lm/ft delivered lumens, 3000K color engine, 120° optic and remote driver. Tape Light should operate on 24VDC voltage and be supplied with a dmx control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Tape Light to be rated for IP65 or equivalent. Tape Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

See plans for exact lengths. Fixture mounting conditions to be confirmed prior to procurement. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Waterproof UltraSlim 2835 LED Strip Light - 3000K - 60/m - 10m reel

Environmental Lights · cULus LISTED · Dimmable · RoHS Compliant

Product Number: wp-3000K-CC2835US-60-6-10m

Call us at 866-343-2908 or Contact Us to set up your corporate account.

Specifications

Ambient Temperature	-20°C to 40°C
Brightness	669 lumens/meter
CRI	90+
CCT	3000K
Country of Origin	China
Efficacy	92.9 lumens/watt
Efficacy 2	0 mWatt/watt
Height (English)	0.19 in
Height (Metric)	4.8 mm
Input Current	3000 mA
IP Rating	IP65
LED Density	60 LEDs/meter
LED Node Size	2835
LED Spacing (English)	0.66 in
LED Spacing (Metric)	16.7 mm
Length (English)	32.81 ft
Length (Metric)	10 m
Manufacturer	Environmental Lights
Min. Cutting Increment (English)	3.94 in
Min. Cutting Increment (Metric)	100 mm
Rating	UL Listed, RoHS
Beam Angle	120°
Input Voltage	24 DC
Warranty	5 years limited
Power (Watts)	72
Power (Watts/ft)	2.2
Power (Watts/m)	7.2
Width (English)	0.39 in

Privacy - Terms

Width (Metric)	9.8 mm

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	WP-RGB3000K-4in1-CC5050-60-12-10m
TOTAL WATTS	2.7
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	32.81' x .47" x .08"
FINISH	White with black extrusion
RATING	IP65
LISTING	UL

SOURCE

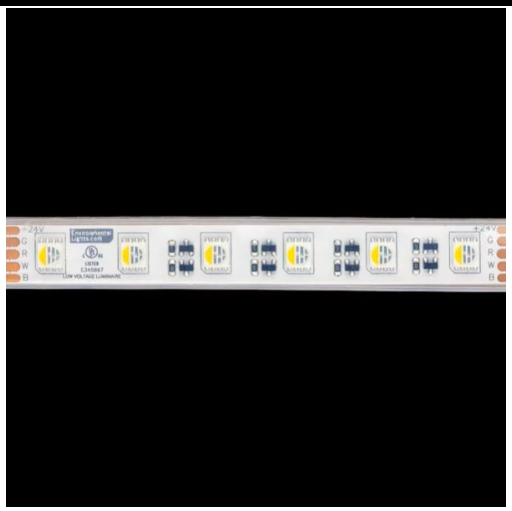
MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGBW 3000K
CRI	
LUMEN OUTPUT	20/72/15/65
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

TYPE	Channel System
MANUFACTURER	Klus
CATALOG NUMBER	CS124



Surface mount fixed tape light with one (1) LED lighting source, 20/72/15/65 delivered lumens, RGBW 3000K color engine, 120° optic and remote driver. Tape Light should operate on 120 voltage and be supplied with a dmx control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Tape light to have white with black extrusion finish. Tape Light to be rated for IP65 or equivalent. Tape Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Waterproof MaxRun RGB + 3000K 4-in-1 5050 LED Strip Light - 60/m - 10m reel

Product Number: wp-RGB3000K-4in1-CC5050-60-12-10m

Specifications

Ambient Temperature	-20°C to 40°C
Brightness	65/235/50/215 lumens/meter
Brightness 2	300/500/700/700mW/meter
Country of Origin	China
Height (English)	0.26 in
Height (Metric)	6.5 mm
Input Current	3750 mA
IP Rating	IP65
LED Density	60 LEDs/meter
LED Node Size	5050
LED Spacing (English)	0.66 in
LED Spacing (Metric)	16.7 mm
Length (English)	32.81 ft
Length (Metric)	10 m
Light Color	RGB + White
Light Color Detail	Red, Green, Blue, 3,000K White
Manufacturer	Environmental Lights
Min. Cutting Increment (English)	3.9 in
Min. Cutting Increment (Metric)	99 mm
Rating	UL, RoHS
Beam Angle	120°
Input Voltage	24 DC
Warranty	5 years limited
Power (Watts)	90
Power (Watts/ft)	2.7
Power (Watts/m)	9
Wavelength	630/520/463
Width (English)	0.63 in
Width (Metric)	16 mm

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	WP-RGB3000K-4in1-CC5050-60-12-10m
TOTAL WATTS	2.7
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	32.81' x .47" x .08"
FINISH	White with black extrusion
RATING	IP65
LISTING	UL

SOURCE

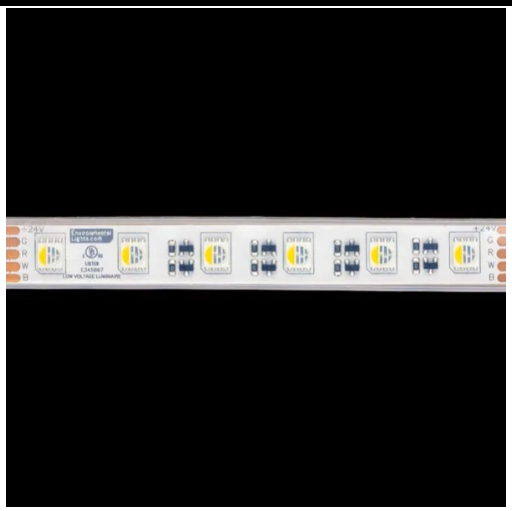
MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGBW 3000K
CRI	
LUMEN OUTPUT	20/72/15/65
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

TYPE	Channel System
MANUFACTURER	Klus
CATALOG NUMBER	CS110-2M-B



Surface mount fixed tape light with one (1) LED lighting source, 20/72/15/65 delivered lumens, RGBW 3000K color engine, 120° optic and remote driver. Tape Light should operate on 120 voltage and be supplied with a dmx control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Tape light to have white with black extrusion finish. Tape Light to be rated for IP65 or equivalent. Tape Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Waterproof MaxRun RGB + 3000K 4-in-1 5050 LED Strip Light - 60/m - 10m reel

Product Number: wp-RGB3000K-4in1-CC5050-60-12-10m

Specifications

Ambient Temperature	-20°C to 40°C
Brightness	65/235/50/215 lumens/meter
Brightness 2	300/500/700/700mW/meter
Country of Origin	China
Height (English)	0.26 in
Height (Metric)	6.5 mm
Input Current	3750 mA
IP Rating	IP65
LED Density	60 LEDs/meter
LED Node Size	5050
LED Spacing (English)	0.66 in
LED Spacing (Metric)	16.7 mm
Length (English)	32.81 ft
Length (Metric)	10 m
Light Color	RGB + White
Light Color Detail	Red, Green, Blue, 3,000K White
Manufacturer	Environmental Lights
Min. Cutting Increment (English)	3.9 in
Min. Cutting Increment (Metric)	99 mm
Rating	UL, RoHS
Beam Angle	120°
Input Voltage	24 DC
Warranty	5 years limited
Power (Watts)	90
Power (Watts/ft)	2.7
Power (Watts/m)	9
Wavelength	630/520/463
Width (English)	0.63 in
Width (Metric)	16 mm

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	WP-RGBA-4in1-CC5050-60-12-10m
TOTAL WATTS	96
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	LENGTH x .47" x .08"
FINISH	White
RATING	IP20
LISTING	UL

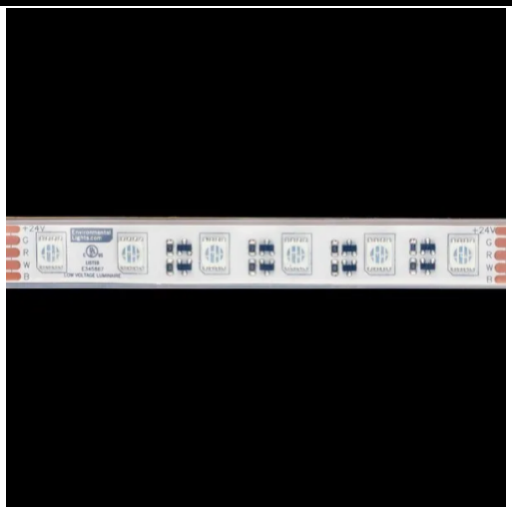
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGBA
CRI	
LUMEN OUTPUT	65/235/50/70 PER METER
ANTICIPATED LIFE	50000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES



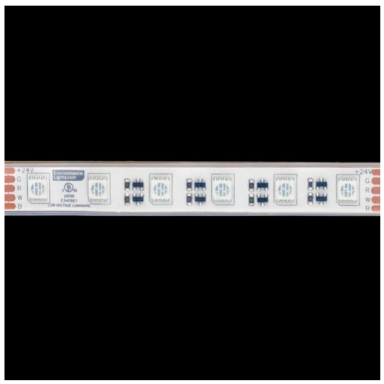
Surface mount fixed tape light with one (1) LED lighting source, 65/235/50/70 PER METER delivered lumens, RGBA color engine, 120° optic and remote driver. Tape Light should operate on 120 voltage and be supplied with a dmx control option and include a minimum 5-year warranty with a 50000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Tape light to have white finish. Tape Light to be rated for IP20 or equivalent. Tape Light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	

NOTES

See plans for exact lengths. Fixture mounting conditions to be confirmed prior to procurement. Extrusion to be confirmed with Millwork before ordering. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.



Waterproof MaxRun RGBA 4-in-1 5050 LED Strip Light - 60/m - 10m reel

Environmental Lights | waterproof | UL US LISTED | Color Change | RoHS Compliant

Product Number: wp-RGBA-4in1-CC5050-60-12-10m

Specifications

Ambient Temperature	-20°C to 40°C
Brightness	65/235/50/70 lumens/meter
Brightness 2	300/500/700/150mW/meter
Country of Origin	China
Height (English)	0.26 in
Height (Metric)	6.5 mm
Input Current	3750 mA
IP Rating	IP65
LED Density	60 LEDs/meter
LED Node Size	5050
LED Spacing (English)	0.66 in
LED Spacing (Metric)	16.7 mm
Length (English)	32.81 ft
Length (Metric)	10 m
Light Color	RGB + Amber
Light Color Detail	Red, Green, Blue, Amber
Manufacturer	Environmental Lights
Min. Cutting Increment (English)	3.9 in
Min. Cutting Increment (Metric)	99 mm
Rating	UL, RoHS
Beam Angle	120°
Input Voltage	24 DC
Warranty	5 years limited
Power (Watts)	90
Power (Watts/ft)	2.7
Power (Watts/m)	9
Wavelength	630/520/463/592
Width (English)	0.63 in
Width (Metric)	16 mm

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	LN-PF-RGB-10m
TOTAL WATTS	96
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	.63" x 1.14"
FINISH	
RATING	IP68
LISTING	RoHS

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGB
CRI	
LUMEN OUTPUT	15/37/8
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

Surface mount fixed led neon with one (1) LED lighting source, 15/37/8 delivered lumens, RGB color engine, 110° optic and remote driver. LED Neon should operate on 120 voltage and be supplied with a dmx control option down to .01% and include a minimum 5-year warranty. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. LED Neon to be rated for IP68 or equivalent. LED Neon should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	RGB

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

EQUIPMENT

MANUFACTURER	Environmental Lights
CATALOG NUMBER	LN-ECO-RGB3000K-5m
TOTAL WATTS	96
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	TBC x 0.39 in x 0.71 in
FINISH	
RATING	IP65
LISTING	UL

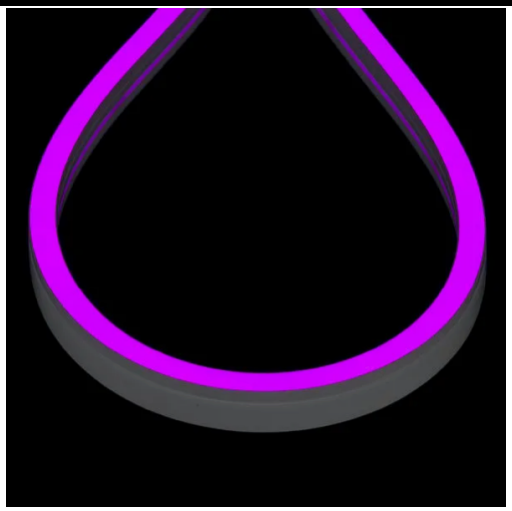
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	RGBW3000K
CRI	
LUMEN OUTPUT	13/41/9/39
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES



Surface mount fixed led neon with one (1) LED lighting source, 13/41/9/39 delivered lumens, RGBW3000K color engine, 120° optic and remote driver. LED Neon should operate on 120 voltage and be supplied with a dmx control option and include a minimum 3-year warranty. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. LED Neon to be rated for IP65 or equivalent. LED Neon should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	DMX
INTENT	RGBW

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

EQUIPMENT

MANUFACTURER	Ligman Lighitng
CATALOG NUMBER	ULD-50071-39w-LED-W
TOTAL WATTS	39
VOLTAGE	120/277v
MOUNTING	Surface
WEIGHT	7.3 lbs
DIMENSIONS	5.7" x 4.7" x 11.2"
FINISH	Black
RATING	IP66
LISTING	UL Wet Listed

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000k
CRI	80+
LUMEN OUTPUT	3568 lm
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	N/A

ACCESSORIES

Surface mount adjustable flood light with one (1) LED lighting source, 3568 lm delivered lumens, 3000k color engine, 80+ CRI and integral driver. Flood Light should operate on 120/277v voltage and be supplied with a 0-10v control option with a 50,000 hour anticipated life. Flood light to have black finish. Flood Light to be rated for IP66 or equivalent. Flood Light should be UL listed for wet use or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

ULD-50071

Lador 4 Threaded Knuckle Floodlight

LIGMAN LIGHTING USA

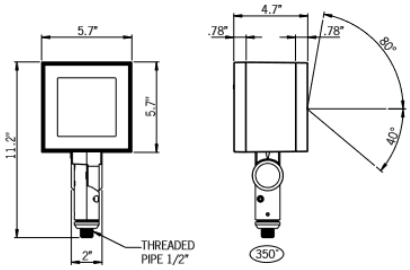
Mounting Options

Yoke Mount [ULD-50031]

Pedestal Mount [ULD-50111]

TURTLE FRIENDLY

39w LED 3568 Lumens
IP66 • Suitable For Wet Locations
IK08 • Impact Resistant (Vandal Resistant)
Weight 7.3 lbs



Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
B5 - U5 - G5

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200 Deg C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
- Resistance to salt-acid room, accelerated aging
- Boiling water, lime and condensed water resistant
- Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
- Super durable (UV resistant)
- TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light. LED CRI > 80

Lumen • Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Square surface architectural floodlight range. Four sizes of square artistic precision with wide range of beam distributions.

A range of square outdoor IP66 floodlight projectors that meets both aesthetic and functional applications. This cubic floodlight range is available with 4 different sizes, starting with a small 2.4" square profile, and increases proportionately to 3" , 4.5" and 5.5" square. This glare free luminaire is available in Narrow 10˚ beam, Medium 19˚, Wide 33˚, Very Wide 71˚ and Elliptical 41˚x14˚ beam patterns.

This luminaire is engineered to meet harsh outdoor environments, as well as being able to be used as a decorative indoor product. The Lador is provided with an integral driver and has accessories that include; dichroic color filters, linear spread lens, honeycomb louvres and anti-glare visors.

This floodlight also has a unique aiming and locking system for precise mounting and beam aiming.

The Lador product family consists of; floodlights, wall sconces, ceiling mounted squares and cluster column event poles.

This luminaire is available with a natatorium rated coating.

Additional Options (Consult Factory For Pricing)

A51414 Linear Spread

A52121 Honeycomb Louvre

A53131 Anti Glare Visor

Dichroic Color Filters

A50181 24" Arm Pedestal

A50281 24" Arm Threaded Knuckle

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

ULD-50071

Lador 4 Threaded Knuckle Floodlight

LIGMAN LIGHTING USA

PROJECT		DATE	
QUANTITY		TYPE		NOTE	
---	---	---	---	---	---

ORDERING EXAMPLE || ULD-50071-39w LED - N - W30 - 02 - 120/277v

ULD-50071					
	LAMP	BEAM	LED COLOR	FINISH COLOR	VOLTAGE
	39w LED 3568 lm	N - Narrow 10° M - Medium 19° W - Wide 33° VW - Very Wide 71° E - Elliptical 41° x 14°	W27 - 2700K W30 - 3000K W35 - 3500K W40 - 4000K	01 - BLACK RAL 9011 02 - DARK GREY RAL 7043 03 - WHITE RAL 9003 04 - METALLIC SILVER RAL 9006 05 - MATTE SILVER RAL 9006 06 - LIGMAN BRONZE 07 - CUSTOM RAL	120/277v Other - Specify

INSPIRED BY NATURE FINISHES

SW01 - OAK FINISH
SW02 - WALNUT FINISH
SW03- PINE FINISH
DF - DOUGLAS FIR FINISH
CW - CHERRY WOOD FINISH
NW - NATIONAL WALNUT FINISH
SU01 - CONCRETE FINISH
SU02 - SOFTSCAPE FINISH
SU03 - STONE FINISH
SU04 - CORTEN FINISH

THERE IS AN ADDITIONAL COST FOR THESE FINISHES

ADDITIONAL OPTIONS

NAT - Natatorium Rated
A51414 - Linear Spread Lens
A52121 - Honeycomb Louvre
A53131 - Anti Glare Visor

DIM - 0-10v Dimming
AMB - Turtle Friendly Amber LED
A50181 - Surface Pedestal 24" Extended Arm
A50281 - 1/2" Threaded 24" Extended Arm

DICHROIC COLOR FILTERS

A51416 - Red Color Filter
A51417 - Blue Color Filter
A51418 - Amber Color Filter
A51419 - Green Color Filter

More Custom Finishes Available Upon Request

Consult factory for pricing and lead times

Oak
Cherry
Beech
Carbon
Walnut
Chestnut
Bamboo
Galvanized
Pine
Mahogany
Birch
Steel

Example: Inspired by Nature Finish

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

Intertek

Lador Product Family

Lador 1

- ULD-50001-3w-222lm
- ULD-50002-4w RGBW-170lm

Lador 2

- ULD-50011-11w-904lm
- ULD-50012-10w RGBW-520lm

Lador 3

- ULD-50021-21w-1975lm
- ULD-50022-22w RGBW-1133lm

Lador 4

- ULD-50031-39w-3568lm
- ULD-50032-28w RGBW-1600lm

Lador 5/50

- ULD-30001-3w-222lm
- ULD-30041-4w RGBW-170lm

Lador 6/51

- ULD-30011-11w-904lm
- ULD-30051-10w RGBW-520lm

Lador 7/52

- ULD-30021-11w-904lm
- ULD-30061-22w RGBW-1133lm

Lador 8/53

- ULD-30031-39w-3568lm
- ULD-30071-28w RGBW-1600lm

Lador 9/32

- ULD-80001-3w-222lm
- ULD-80041-4w RGBW-170lm

Lador 10/33

- ULD-80011-11w-904lm
- ULD-80051-10w RGBW-520lm

Lador 11/34

- ULD-80021-21w-1975lm
- ULD-80061-22w RGBW-1133lm

Lador 12/35

- ULD-80031-39w-3568lm
- ULD-80071-28w RGBW-1600lm

Lador 13/14/15

- ULD-20011-4x21w-4x1975lm [13']
- ULD-20021-4x39w-4x3568lm [13']
- ULD-20012-4x21w-4x1975lm [19.6']
- ULD-20022-4x39w-4x3568lm [19.6']
- ULD-20011-4x21w-4x1975lm [26.2']
- ULD-20011-4x39w-4x3568lm [26.2']

Lador 1 TKM

- ULD-50041-3w-222lm

Lador 2 TKM

- ULD-50051-11w-904lm

Lador 3 TKM

- ULD-50061-21w-1975lm

Lador 4 TKM

- ULD-50071-39w-3568lm

Lador 20/42

- ULD-50081-3w-222lm
- ULD-50201-4w RGBW-170lm

Lador 21/43

- ULD-50091-11w-904lm
- ULD-50211-10w-520lm

Lador 22/44

- ULD-50101-21w-1975lm
- ULD-50221-22w RGBW-1133lm

Lador 23

- ULD-50111-39w-3568lm
- ULD-50231-28w RGBW-1600lm

ULD-50071

Lador 4 Threaded Knuckle Floodlight

LIGMAN LIGHTING USA

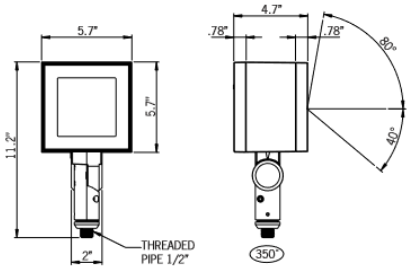
Mounting Options

Yoke Mount [ULD-50031]

Pedestal Mount [ULD-50111]

TURTLE FRIENDLY

39w LED 3568 Lumens
IP66 • Suitable For Wet Locations
IK08 • Impact Resistant (Vandal Resistant)
Weight 7.3 lbs



Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
B5 - U5 - G5

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200 Deg C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
- Resistance to salt-acid room, accelerated aging
- Boiling water, lime and condensed water resistant
- Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
- Super durable (UV resistant)
- TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light. LED CRI > 80

Lumen • Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Square surface architectural floodlight range. Four sizes of square artistic precision with wide range of beam distributions.

A range of square outdoor IP66 floodlight projectors that meets both aesthetic and functional applications. This cubic floodlight range is available with 4 different sizes, starting with a small 2.4" square profile, and increases proportionately to 3" , 4.5" and 5.5" square. This glare free luminaire is available in Narrow 10˚ beam, Medium 19˚, Wide 33˚, Very Wide 71˚ and Elliptical 41˚x14˚ beam patterns.

This luminaire is engineered to meet harsh outdoor environments, as well as being able to be used as a decorative indoor product. The Lador is provided with an integral driver and has accessories that include; dichroic color filters, linear spread lens, honeycomb louvres and anti-glare visors.

This floodlight also has a unique aiming and locking system for precise mounting and beam aiming.

The Lador product family consists of; floodlights, wall sconces, ceiling mounted squares and cluster column event poles.

This luminaire is available with a natatorium rated coating.

Additional Options (Consult Factory For Pricing)

A51414 Linear Spread

A52121 Honeycomb Louvre

A53131 Anti Glare Visor

Dichroic Color Filters

A50181 24" Arm Pedestal

A50281 24" Arm Threaded Knuckle

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

ULD-50071

Lador 4 Threaded Knuckle Floodlight

LIGMAN LIGHTING USA

PROJECT		DATE	
QUANTITY		TYPE	
NOTE			

ORDERING EXAMPLE || ULD-50071-39w LED - N - W30 - 02 - 120/277v

ULD-50071					
	LAMP	BEAM	LED COLOR	FINISH COLOR	VOLTAGE
	39w LED 3568 lm	N - Narrow 10° M - Medium 19° W - Wide 33° VW - Very Wide 71° E - Elliptical 41° x 14°	W27 - 2700K W30 - 3000K W35 - 3500K W40 - 4000K	01 - BLACK RAL 9011 02 - DARK GREY RAL 7043 03 - WHITE RAL 9003 04 - METALLIC SILVER RAL 9006 05 - MATTE SILVER RAL 9006 06 - LIGMAN BRONZE 07 - CUSTOM RAL	120/277v Other - Specify

INSPIRED BY NATURE FINISHES

SW01 - OAK FINISH
SW02 - WALNUT FINISH
SW03- PINE FINISH
DF - DOUGLAS FIR FINISH
CW - CHERRY WOOD FINISH
NW - NATIONAL WALNUT FINISH
SU01 - CONCRETE FINISH
SU02 - SOFTSCAPE FINISH
SU03 - STONE FINISH
SU04 - CORTEN FINISH

THERE IS AN ADDITIONAL COST FOR THESE FINISHES

ADDITIONAL OPTIONS

NAT - Natatorium Rated
A51414 - Linear Spread Lens
A52121 - Honeycomb Louvre
A53131 - Anti Glare Visor

DIM - 0-10v Dimming
AMB - Turtle Friendly Amber LED
A50181 - Surface Pedestal 24" Extended Arm
A50281 - 1/2" Threaded 24" Extended Arm

DICHROIC COLOR FILTERS

A51416 - Red Color Filter
A51417 - Blue Color Filter
A51418 - Amber Color Filter
A51419 - Green Color Filter

More Custom Finishes Available Upon Request

Consult factory for pricing and lead times

Oak
Cherry
Beech
Carbon
Walnut
Chestnut
Bamboo
Galvanized
Pine
Mahogany
Birch
Steel

Example: Inspired by Nature Finish

Intertek

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

Lador Product Family

Lador 1

- ULD-50001-3w-222lm
- ULD-50002-4w RGBW-170lm

Lador 2

- ULD-50011-11w-904lm
- ULD-50012-10w RGBW-520lm

Lador 3

- ULD-50021-21w-1975lm
- ULD-50022-22w RGBW-1133lm

Lador 4

- ULD-50031-39w-3568lm
- ULD-50032-28w RGBW-1600lm

Lador 5/50

- ULD-30001-3w-222lm
- ULD-30041-4w RGBW-170lm

Lador 6/51

- ULD-30011-11w-904lm
- ULD-30051-10w RGBW-520lm

Lador 7/52

- ULD-30021-11w-904lm
- ULD-30061-22w RGBW-1133lm

Lador 8/53

- ULD-30031-39w-3568lm
- ULD-30071-28w RGBW-1600lm

Lador 9/32

- ULD-80001-3w-222lm
- ULD-80041-4w RGBW-170lm

Lador 10/33

- ULD-80011-11w-904lm
- ULD-80051-10w RGBW-520lm

Lador 11/34

- ULD-80021-21w-1975lm
- ULD-80061-22w RGBW-1133lm

Lador 12/35

- ULD-80031-39w-3568lm
- ULD-80071-28w RGBW-1600lm

Lador 13/14/15

- ULD-20011-4x21w-4x1975lm [13']
- ULD-20021-4x39w-4x3568lm [13']
- ULD-20012-4x21w-4x1975lm [19.6']
- ULD-20022-4x39w-4x3568lm [19.6']
- ULD-20011-4x21w-4x1975lm [26.2']
- ULD-20011-4x39w-4x3568lm [26.2']

Lador 1 TKM

- ULD-50041-3w-222lm

Lador 2 TKM

- ULD-50051-11w-904lm

Lador 3 TKM

- ULD-50061-21w-1975lm

Lador 4 TKM

- ULD-50071-39w-3568lm

Lador 20/42

- ULD-50081-3w-222lm
- ULD-50201-4w RGBW-170lm

Lador 21/43

- ULD-50091-11w-904lm
- ULD-50211-10w-520lm

Lador 22/44

- ULD-50101-21w-1975lm
- ULD-50221-22w RGBW-1133lm

Lador 23

- ULD-50111-39w-3568lm
- ULD-50231-28w RGBW-1600lm

EQUIPMENT

MANUFACTURER	Sistemalux
CATALOG NUMBER	SSHF4-3-154-930-1FLD-1FLD-1FLD-REM -09-S1468
TOTAL WATTS	114
VOLTAGE	120-277
MOUNTING	Pole
WEIGHT	44.3 lb
DIMENSIONS	4" x 4" x 154"
FINISH	Black
RATING	IP66
LISTING	IK10

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	3
CCT	3000K
CRI	90+
LUMEN OUTPUT	995
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

TYPE	Driver
MANUFACTURER	Sistemalux
CATALOG NUMBER	TBD

Pole mount adjustable flood with three (3) LED lighting sources each, 995 delivered lumens, 3000K color engine, 90+ CRI, 51° optic and remote driver. Flood should operate on 120-277 voltage and be supplied with a 0-10v control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Flood to have black finish. Flood to be rated for IP66 or equivalent. Flood should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

SHIFT 4-3

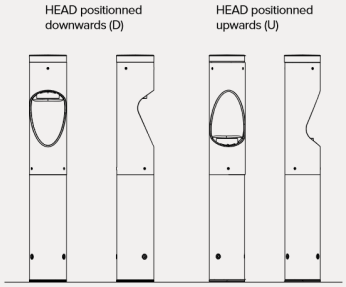
Pole remote

Project: _____

Type: _____

CONFIGURE

SSHF4-3-154



Family of outdoor fixture integrating adjustable spotlight in the cylindrical shape of the pole that can be independently controlled and freely rotated on their axis.

PHOTOMETRIC SUMMARY

Model	Power (W)	Optic	Lumens (Lm)	Efficacy (Lm/W)	Candela (cd)	BUG
SSHF4-3-154-930-XSPX	14.7	16°	719	49	5 808	B0 U1 G0
SSHF4-3-154-930-XFLX		51°	995	68	1 357	B0 U1 G0
SSHF4-3-154-930-XELX		19° x 54°	527	36	1 793	B0 U1 G0

For 3000K, 90CRI. Consult page 5 for full photometric data.

FEATURES

- 0-10V, DALI, DMX, (120-277V) down to 1%, LTE (120V) down to 1%
- Remote LED driver options page 2
- Dimensions and adjustments page 3
- Mounting details page 4
- Full specification available page 3
- Consult factory for further customization

FINISH OPTIONS

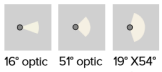
09 24

PREMIUM

01 07 14 20

Consult factory for custom finishes

OPTIC OPTIONS



16° optic 51° optic 19° X54° optic

IK 10 IP 66

CE Equivalent Available | cULus | 5-Year Limited Warranty

ORDERING INFO

SSHF4-3-154- - - - -REM-

PRODUCT CODE

EXAMPLE: Head 3, SSHF4-3-154-927-1FLD-2FLD-3SPU-REM-09

SSHF4-3	154					REM	

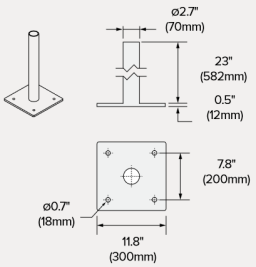
MODEL	HEIGHT	LED	HEAD 1*	HEAD 2*	HEAD 3*	VOLTAGE	FINISH
SSHF4-3 Shift 4 Pole Ø4" (102mm) with 3 heads	**154** 154 ⅛" (3915 mm)	**927** 2700K, 90CRI **930** 3000K, 90CRI **840** 4000K, 80CRI	**1SPD** Head 1 down, 16° optic. **1SPU** Head 1 up, 16° optic. **1FLD** Head 1 down, 51° optic. **1FLU** Head 1 up, 51° optic. **1ELD** Head 1 down, 19x 54° optic. **1ELU** Head 1 up, 19x 54° optic.	**2SPD** Head 2 down, 16° optic. **2SPU** Head 2 up, 16° optic. **2FLD** Head 2 down, 51° optic. **2FLU** Head 2 up, 51° optic. **2ELD** Head 2 down, 19X54° optic. **2ELU** Head 2 up, 19X54° optic.	**3SPD** Head 3 down, 16° optic. **3SPU** Head 3 up, 16° optic. **3FLD** Head 3 down, 51° optic. **3FLU** Head 3 up, 51° optic. **3ELD** Head 3 down, 19X54° optic. **3ELU** Head 3 up, 19X54° optic.	**REM** Remote	**09** Black **24** Anthracite gray *Premium* [1] **01** White **07** Green **14** Aluminum gray **20** Burnished Bronze

1 Surcharge applies on premium finishes.

MANDATORY MOUNTING

Included

S1468
Ø2.75" (Ø70mm)
Fixing base for Shift 4 pole.
Bolt or threaded rod 5/8"
(M16) not included



SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

Visual Terrain®
www.visualterrain.net

DATE: 10/23/2026	REVISION #	PROJECT: Bentonville Ballroom CLIENT: Live Nation SUBMISSION: 100% Detail Design DOCUMENT #:
PAGE 456 OF 505	0	Equipment Page 2 of 6

EQUIPMENT TYPE

P51

SHIFT 4-3

Pole remote

Project: _____

Type: _____

REMOTE LED DRIVER OPTIONS

To be ordered separately.

DRIVER CODE

EXAMPLE: 4445-0500-009-120-LTE

INDOOR RATED DRIVER BOX MODELS	MAX DISTANCE**	MIN-MAX UNITS CONSTANT CURRENT 350mA, 3 X 12.7W*
D10		
☐ 4448-0350-079-UNV-SD10	118ft (36m)	1 (heads controlled together)
☐ 4450-0350-084-UNV-D10-6TRL	40ft (12m)	1-2 (heads controlled together)
☐ 4450-0350-042-UNV-D10-3TRL		1 (heads controlled together)
DALI		
☐ 4449-0350-114-UNV-DDA-3TRL	118ft (36m)	1-2 (heads controlled separately)
☐ 4449-0350-076-UNV-DDA-2TRL		1 (heads controlled separately)
DMX		
☐ 4450-0350-050-UNV-PDMX	118ft (36m)	1 (heads controlled separately)
LTE		
☐ 4450-0350-084-120-LTE-6TRL	40ft (12m)	1-2 (heads controlled together)
☐ 4450-0350-042-120-LTE-3TRL		1 (heads controlled together)

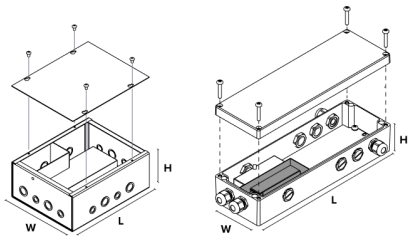
OUTDOOR RATED DRIVER BOX MODELS	MAX DISTANCE**	MIN-MAX UNITS CONSTANT CURRENT 350mA, 3 X 12.7W*
D10		
☐ 4549-0350-079-UNV-SD10	118ft (36m)	1 (heads controlled together)
☐ 4555-0350-084-UNV-D10-6TRL	40ft (12m)	1-2 (heads controlled together)
☐ 4549-0350-042-UNV-D10-3TRL		1 (heads controlled together)
DALI		
☐ 4555-0350-114-UNV-DDA-3TRL	118ft (36m)	1-2 (heads controlled separately)
☐ 4555-0350-076-UNV-DDA-2TRL		1 (heads controlled separately)
DMX		
☐ 4549-0350-050-UNV-PDMX	118ft (36m)	1 (heads controlled separately)
LTE		
☐ 4555-0350-084-120-LTE-6TRL	40ft (12m)	1-2 (heads controlled together)
☐ 4549-0350-042-120-LTE-3TRL		1 (heads controlled together)

* Wattage requirement for one (1) fixture.
**Max distance cable calculated for 16AWG cable. Contact customer service for longer remote distance.

DRIVER BOX MODEL DESCRIPTION

MODEL (L × W × H)	CONSTANT CURRENT	WATTAGE	VOLTAGE	DIMMING PROTOCOL
4448 10" x 8" x 4" (254 x 203 x 102mm)	**0350** 350mA	**038 to 114** 38W to 114W	**120** 120V	**D10** 0-10V down to 1%
4449 12" x 8" x 4" (304 x 203 x 102mm)			**UNV** 120-277V	**SD10** 0-10V down to 0.1%
4450 8" x 8" x 4" (203 x 203 x 102mm)				**DDA** DALI down to 1%
4549 14.5" x 5" x 3.5" (368 x 127 x 89mm)				**PDMX** DMX RDM down to 1%
4555 13" x 9" x 4.5" (330 x 230 x 113mm)				**LTE** Leading and Trailing edge down to 1%

DRIVER BOX DIMENSIONS

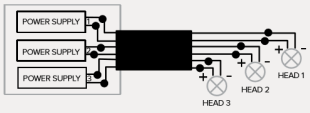


INDOOR RATED

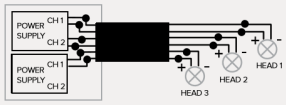
OUTDOOR RATED

WIRING DIAGRAMS

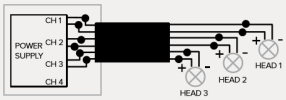
D10 / LTE
Multiple heads are controlled together and connected on different outputs.
Wire for 3 heads: 6/18 AWG



DALI
Multiple heads are controlled separately and connected on different channels.
Wire for 3 heads: 6/18 AWG



DMX
Multiple heads are controlled separately and connected on different channels.
Wire for 3 heads: 6/18 AWG



SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-3

Pole remote

Project: _____

Type: _____

SPECIFICATIONS

LUMEN MAINTENANCE

80% of initial lumens at 70 000 hours (L80 B10) Ta 77°F (25°C)
80% of initial lumens at 50 000 hours (L80 B10) Ta 104°F (40°C) (LM-80)

OPTICS

Spot 16°
Wide flood 51°
Elliptical 19° X 54°

BUG RATING

For all optics,
Head down 0°: B0 U1 G0
Head 45°: B0 U1 G0

MATERIAL

Boby: Die-cast aluminum
Diffuser: Toughened glass.

MOUNTING

Install with mandatory base included with product *page 4*

ADJUSTMENT

Each head can pan 355° and tilt 90°

ELECTRICAL

Constant current 350mA.
See remote LED driver options on *page 2*

DIMMING

See dimmable options on *page 2*

FINISH

Anthracite gray (24) or black (09) painted finish, following a double powder paint in 3 step process: surface treatment containing ceramic nano particles (Bonderite). Epoxy primer paint. Polyester powder paint with high resistance against UV rays and harsh weather conditions.
See *page 1* for other premium finishes available: white (01), green (07), aluminum gray (14) and burnished bronze (20).
Resistance test protection Marine applications : 1200h.
We provide RAL numbers that are similar, but we cannot guarantee an exact color match. For a more accurate color and gloss match, please contact customer service for a sample chip.
Similar RAL numbers:
Anthracite gray RAL9007, black RAL9005, white RAL9016, green RAL6028, aluminum gray RAL9006 and burnished bronze RAL8019.

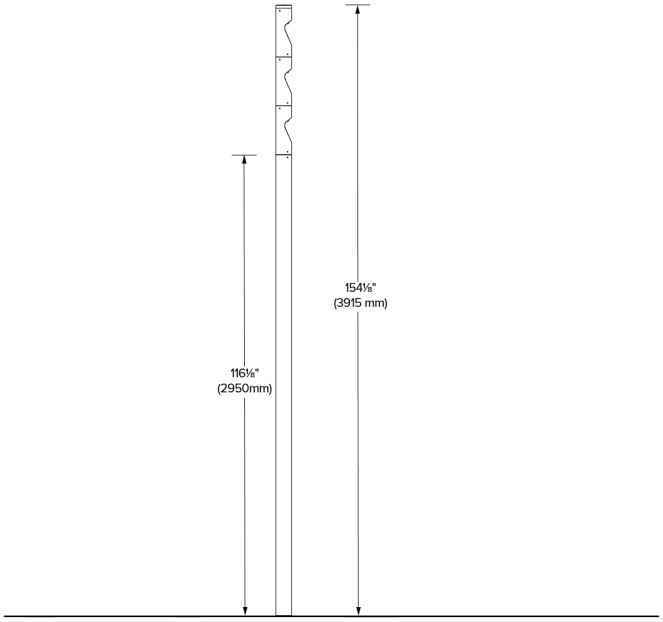
OPERATING TEMPERATURE

-4°F to 122°F (-20°C a +50°C)

WEIGHT

SSHF4-3-154 H 154 ⅛" (3915mm) : 44.34lb (20.15 kg)

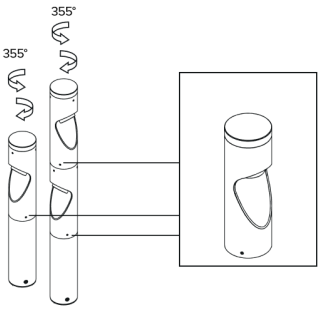
DIMENSIONS



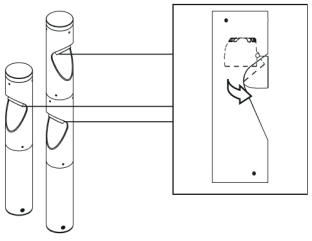
SSHF4-3-154

ADJUSTMENT

Pan 355°



Tilt 90°



SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-3

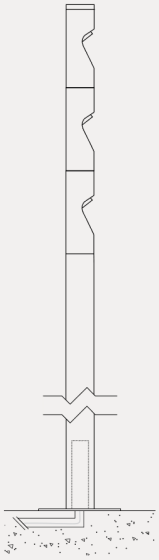
Pole remote

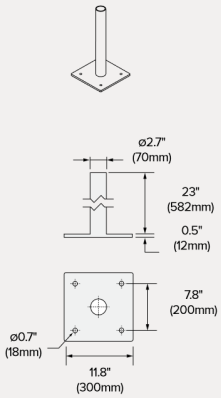
Project: _____

Type: _____

MANDATORY MOUNTING

SHIFT 4-3-154





REM - Mounting on solid surface with mandatory base (S1468) included with SHIFT 4-3 Pole. This base requires 5/8" (M16) stainless steel fixing screws (not included). Needs recessed channel or gutter. The mounting base will be deliver the same finish as the fixture.

SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-3

Pole remote

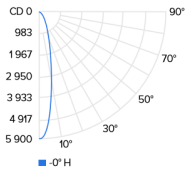
Project:

Type:

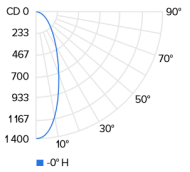
PHOTOMETRIC DATA

CCT (K)	CRI	POWER (W)	OPTIC	LUMENS (lm)	EFFICACY (lm/W)	MAX CANDELA (cd)	BUG	MODELS
3000	90	3 x 14.7	16°	719	49	5 808	B0 U1 G0	SSHF4-3-154-930-XSPX
			51°	995	68	1 357		SSHF4-3-154-930-XFLX
			19° X 54°	527	36	1 793		SSHF4-3-154-930-XELX

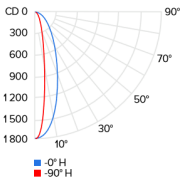
16° Optic (3000K, 90CRI)



51° Optic (3000K, 90CRI)



19° x 54° Optic (3000K, 90CRI)



CCT options	2700K	3000K	4000K
CRI options	90CRI	90CRI	80CRI
Multiplier	**0.94**	**1**	**1.04**

Use multiplier table for other cct and cri output data. efficacy based on iesna lm-79 test reports.

SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

EQUIPMENT

MANUFACTURER	Sistemalux
CATALOG NUMBER	SSHF4-1-037-930-1FLD-NA-NA-REM-09-S2148
TOTAL WATTS	38
VOLTAGE	120-277
MOUNTING	Pole
WEIGHT	12.7 lb
DIMENSIONS	37 7/16" x 4" x 154"
FINISH	Black
RATING	IP66
LISTING	IK10

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	995
ANTICIPATED LIFE	50,000

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

TYPE	Driver
MANUFACTURER	Sistemalux
CATALOG NUMBER	TBD

Pole mount adjustable flood with one (1) LED lighting source, 995 delivered lumens, 3000K color engine, 90+ CRI, 51° optic and remote driver. Flood should operate on 120-277 voltage and be supplied with a 0-10v control option and include a minimum 5-year warranty with a 50,000 hour anticipated life. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Flood to have black finish. Flood to be rated for IP66 or equivalent. Flood should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

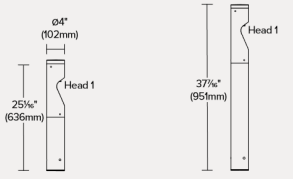
SHIFT 4-1

Bollard remote

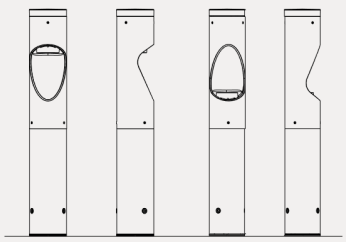
Project: _____

Type: _____

CONFIGURE



SSHF4-1-025 SSHF4-1-037



Family of bollards integrating adjustable spotlight in the cylindrical shape of the pole that can be independently controlled and freely rotated on their axis.

PHOTOMETRIC SUMMARY

Model	Power (W)	Optic	Lumens (lm)	Efficacy (lm/W)	Candela (cd)	BUG
SSHF4-1-025-930-XSPX SSHF4-1-037-930-XSPX	14.7	16°	719	49	5 808	B0 U1 G0
SSHF4-1-025-930-XFLX SSHF4-1-037-930-XFLX		51°	995	68	1 357	B0 U1 G0
SSHF4-1-025-930-XELX SSHF4-1-037-930-XELX		19° x 54°	527	36	1 793	B0 U1 G0

For 3000K, 90CRI. Consult page 5 for full photometric data.

FEATURES

- 0-10V, DALI, DMX, (120-277V) down to 1%, LTE (120V) down to 1%
- Remote LED driver options page 2
- Up to 2 additional heads page 1
- Dimensions and adjustments page 3
- Mounting options page 4
- Full specification available page 3
- Consult factory for further customization

FINISH OPTIONS

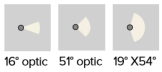
09 24

PREMIUM

01 07 14 20

Consult factory for custom finishes

OPTIC OPTIONS



16° optic 51° optic 19° X54° optic

IK 10 IP 66

CE CE Equivalent Available cULus 5-Year Limited Warranty

ORDERING INFO

SSHF4-1- - - -NA-NA-REM-

PRODUCT CODE EXAMPLE: Head 3, SSHF4-1-025-927-1FLD-NA-NA-REM-09

SSHF4-1				NA	NA	REM	

MODEL	HEIGHT	LED	HEAD 1*	HEAD 2*	HEAD 3*	VOLTAGE	FINISH
SSHF4-1 Shift 4 Bollard Ø4" (102mm) with 1 head	**025** 25⅛" (636mm) **037** 37⅜" (951mm)	**927** 2700K, 90CRI **930** 3000K, 90CRI **840** 4000K, 80CRI	**1SPD** Head 1 down, 16° optic. **1SPU** Head 1 UP, 16° optic. **1FLD** Head 1 down, 51° optic. **1FLU** Head 1 up, 51° optic. **1ELD** Head 1 down, 19x 54° optic. **1ELU** Head 1 up, 19x 54° optic.	**NA** No head 2	**NA** No head 3	**REM** Remote	**09** Black **24** Anthracite gray *Premium* [1] **01** White **07** Green **14** Aluminum gray **20** Burnished Bronze

***Additional heads** can be added to Shift 4-1 Bollard. You can add up to 2 heads obtaining a configuration of 2 for maximum 3 heads. Heads can be controlled separately. See 2 or 3 head model or optional additional head specification sheet. Additional heads can be also turned upside down to light up.

1 Surcharge applies on premium finishes.

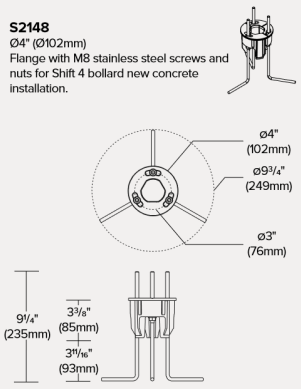
MOUNTING ACCESSORIES

To be ordered separately.

MOUNTING ACCESSORY CODE EXAMPLE:S2148

OPTIONAL FOR SHIFT 4 BOLLARD

☐ **S2148**
Ø4" (Ø102mm)
Flange with M8 stainless steel screws and nuts for Shift 4 bollard new concrete installation.



SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-1
Bollard remote

Project: _____
Type: _____

REMOTE LED DRIVER OPTIONS

To be ordered separately.

DRIVER CODE

EXAMPLE: 4445-0500-009-120-LTE

INDOOR RATED DRIVER BOX MODELS	MAX DISTANCE**	MIN-MAX UNITS CONSTANT CURRENT 350mA, 12.7W*
D10		
☐ 4448-0350-079-UNV-SD10	118ft (36m)	1-4
☐ 4450-0350-042-UNV-D10-3TRL	40ft (12m)	1-3
☐ 4450-0350-028-UNV-D10-2TRL		1-2
☐ 4445-0350-014-UNV-D10		1
DALI		
☐ 4449-0350-076-UNV-DDA-2TRL	118ft (36m)	1-4
☐ 4450-0350-038-UNV-DDA		1-2
☐ 4450-0350-019-UNV-EDA		1
DMX		
☐ 4450-0350-050-UNV-PDMX	118ft (36m)	1-4
LTE		
☐ 4450-0350-042-120-LTE-3TRL	40ft (12m)	1-3
☐ 4450-0350-028-120-LTE-2TRL		1-2
☐ 4445-0350-014-120-LTE		1

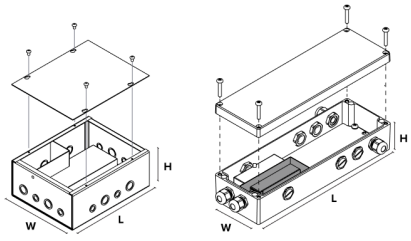
OUTDOOR RATED DRIVER BOX MODELS	MAX DISTANCE**	MIN-MAX UNITS CONSTANT CURRENT 350mA, 12.7W*
D10		
☐ 4549-0350-079-UNV-SD10	118ft (36m)	1-4
☐ 4549-0350-042-UNV-D10-3TRL	40ft (12m)	1-3
☐ 4549-0350-028-UNV-D10-2TRL		1-2
☐ 4548-0350-014-UNV-D10		1
DALI		
☐ 4555-0350-076-UNV-DDA-2TRL	118ft (36m)	1-4
☐ 4549-0350-038-UNV-DDA		1-2
☐ 4549-0350-019-UNV-EDA		1
DMX		
☐ 4549-0350-050-UNV-PDMX	118ft (36m)	1-4
LTE		
☐ 4549-0350-042-120-LTE-3TRL	40ft (12m)	1-3
☐ 4549-0350-028-120-LTE-2TRL		1-2
☐ 4548-0350-014-120-LTE		1

* Wattage requirement for one (1) fixture.
**Max distance cable calculated for 16AWG cable. Contact customer service for longer remote distance.

DRIVER BOX MODEL DESCRIPTION

MODEL (L × W × H)	CONSTANT CURRENT	WATTAGE	VOLTAGE	DIMMING PROTOCOL
4445 6" x 6" x 3" (152 x 152 x 76mm)	**0350** 350mA	**014 to 079** 14W to 79W	**120** 120V	**D10** 0-10V down to 1%
4448 10" x 8" x 4" (254 x 203 x 102mm)			**UNV** 120-277V	**SD10** 0-10V down to 0.1%
4449 12" x 8" x 4" (304 x 203 x 102mm)				**EDA or DDA** DALI down to 1%
4450 8" x 8" x 4" (203 x 203 x 102mm)				**PDMX** DMX RDM down to 1%
4548 6" x 4.5" x 3" (152 x 114 x 76mm)				**LTE** Leading and Trailing edge down to 1%
4549 14.5" x 5" x 3.5" (368 x 127 x 89mm)				
4555 13" x 9" x 4.5" (330 x 230 x 113mm)				

DRIVER BOX DIMENSIONS



INDOOR RATED

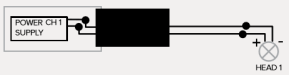
OUTDOOR RATED

WIRING DIAGRAMS

D10 / LTE
Multiple heads are controlled together and connected on different outputs.
Wire for 1 head: 2/18 AWG

DALI
Multiple heads are controlled separately and connected on different channels.
Wire for 1 head: 2/18 AWG

DMX
Multiple heads are controlled separately and connected on different channels.
Wire for 1 head: 2/18 AWG



SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-1
Bollard remote

Project: _____
Type: _____

SPECIFICATIONS

LUMEN MAINTENANCE
80% of initial lumens at 70 000 hours (L80 B10) Ta 77°F (25°C)
80% of initial lumens at 50 000 hours (L80 B10) Ta 104°F (40°C) (LM-80)

OPTICS
Spot 16°
Wide flood 51°
Elliptical 19° X 54°

BUG RATING
For all optics,
Head down 0°: B0 U1 G0
Head 45°: B0 U1 G0

MATERIAL
Boby: Die-cast aluminum
Diffuser: Toughened glass.

MOUNTING
Install with flange accessory or fasten to solid ground.

ADJUSTMENT
Each head can pan 355° and tilt 90°

ELECTRICAL
Constant current 350mA.
See remote LED driver options on page 2

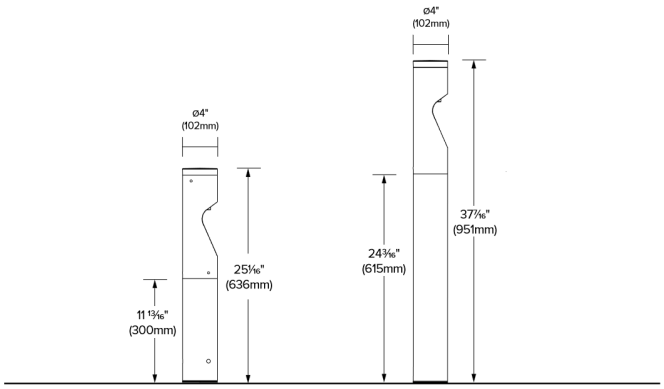
DIMMING
See dimmable options on page 2

FINISH
Anthracite gray (24) or black (09) painted finish, following a double powder paint in 3 step process: surface treatment containing ceramic nano particles (Bonderite). Epoxy primer paint. Polyester powder paint with high resistance against UV rays and harsh weather conditions.
See page 1 for other premium finishes available: white (01), green (07), aluminum gray (14) and burnished bronze (20).
Resistance test protection Marine applications : 1200h.
We provide RAL numbers that are similar, but we cannot guarantee an exact color match. For a more accurate color and gloss match, please contact customer service for a sample chip.
Similar RAL numbers:
Anthracite gray RAL9007, black RAL9005, white RAL9016, green RAL6028, aluminum gray RAL9006 and burnished bronze RAL8019.

OPERATING TEMPERATURE
-4°F to 122°F (-20°C a +50°C)

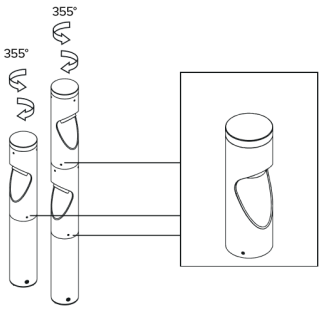
WEIGHT
SSHF4-1-025 H 25" (635mm) : 10lb (4.56kg)
SSHF4-1-037 H 37 ⅜" (950mm) : 12.7lb (5.76kg)
Additionnal Heads: H 12 ⅜" (315mm) : 5.6lb (2.56 kg)

DIMENSIONS

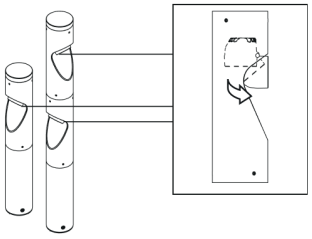


ADJUSTMENT

Pan 355°



Tilt 90°



DM-R0 | Last Update: September 19, 2025

SISTEMALUX

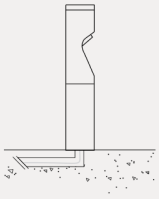
Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-1
Bollard remote

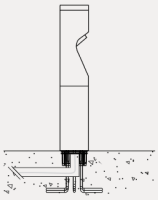
Project:
Type:

MOUNTING OPTIONS

SHIFT 4-1-025

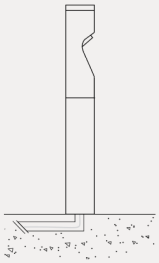


REM - Installed directly the fixture base to solid surface with recessed channel or gutter. Bolts and anchors not included. Use size #5/16 or M8 bolts.

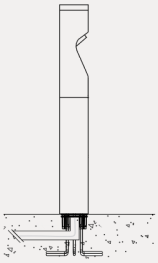


REM - Mounting with flange, stainless steel screws included, (S2148) to be ordered separately, page 1. For new installation with poured concrete and recessed channel or gutter.

SHIFT 4-1-037



REM - Installed directly the fixture base to solid surface with recessed channel or gutter. Bolts and anchors not included. Use size #5/16 or M8 bolts.



REM - Mounting with flange, stainless steel screws included, (S2148) to be ordered separately, page 1. For new installation with poured concrete and recessed channel or gutter.

SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

SHIFT 4-1

Bollard remote

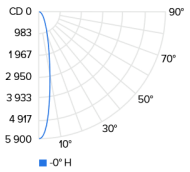
Project:

Type:

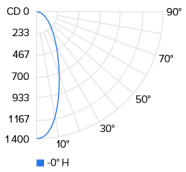
PHOTOMETRIC DATA

CCT (K)	CRI	POWER (W)	OPTIC	LUMENS (lm)	EFFICACY (lm/W)	MAX CANDELA (cd)	BUG	MODELS
3000	90	14.7	16°	719	49	5 808	B0 U1 G0	SSHF4-1-0XX-930-1SPX
			51°	995	68	1 357		SSHF4-1-0XX-930-XFLX
			19° X 54°	527	36	1 793		SSHF4-1-0XX-930-XELX

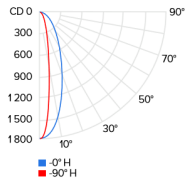
16° Optic (3000K, 90CRI)



51° Optic (3000K, 90CRI)



19° x 54° Optic (3000K, 90CRI)



CCT options	2700K	3000K	4000K
CRI options	90CRI	90CRI	80CRI
Multiplier	**0.94**	**1**	**1.04**

Use multiplier table for other cct and cri output data. efficacy based on iesna lm-79 test reports.

SISTEMALUX

Due to continuous improvements, the information herein may be changed without notice.
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7 | P 514.523.1339 | F 514.525.6107 | www.sistemalux.com

EQUIPMENT

MANUFACTURER	HALO
CATALOG NUMBER	L652-MB
TOTAL WATTS	
VOLTAGE	120
MOUNTING	Surface
WEIGHT	
DIMENSIONS	92 1/8" x 1 3/8" x 11/16"
FINISH	Black
RATING	IP
LISTING	UL

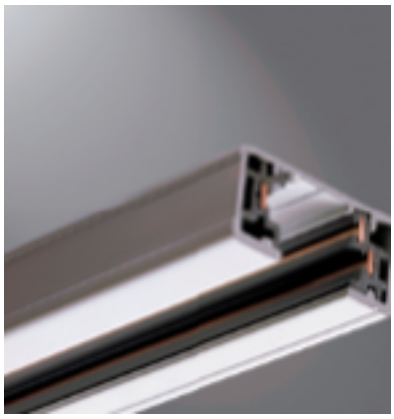
SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	0
CCT	
CRI	
LUMEN OUTPUT	
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	N/A
PROVIDED BY	

ACCESSORIES



Surface mount fixed track should operate on 120 voltage with line voltage dimmer circuit.Track to have black finish. System to be mounted as indicated on plans. System components to be fabricated by the same manufacturer, e.g. track heads, track, connectors, hardware, etc, to ensure compatibility. Track should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	

NOTES

Contractor to submit manufacturer's shop drawings of track system detailing length and mounting methods for approval prior to procurement. Contractor to field verify and confirm overall dimensions, instillation requirements, and mounting hardware per manufacturer recommendation. Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

T50A
L652-MB

HALO

DESCRIPTION

Miniature size, decorator finishes, push-in connectors, economy, all combine to make single-circuit Miniature Trac perfect for residential or commercial use. Polarized connectors and end caps are molded polycarbonate. Halo Miniature Track accepts both Halo and Lazer-by-Halo lampholders.

Catalog #		Type	
Project			
Comments		Date	
Prepared by			

SPECIFICATION FEATURES

A. Structural
- Extruded aluminum .060" [1.5mm] nominal wall thickness

B. Line Conductor
- Solid copper bus bars [cross section equivalent to #12 AWG wire].

C. Insulating Liner
- Extruded polyvinyl insulator.

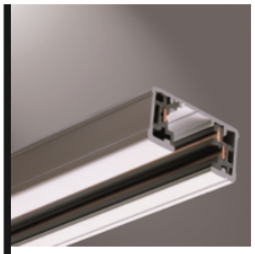
D. Ground Conductor
- Exclusive independent grounding bus conductor. Maintains an independent positive ground #12 AWG path between lampholder, Trac channel and building's ground system.

E. Neutral Conductor
- Cross section equivalent of #12 AWG wire.

F. Polarity Indicator (Neutral)
- Visual polarity groove indicates proper electrical installation of lampholder adapter.

Listings
- cULus listed for use with Halo and Lazer-by-Halo lampholders.

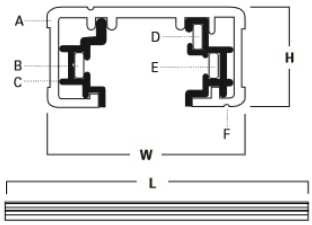
Mounting
- Track system is recommended for ceiling mount only. For alternate mounting methods consult factory.



L650, L651
L652, L653

MINIATURE SINGLE CIRCUIT TRAC SYSTEM

Power -Trac



	L	W	H
L650 2' Nominal	20-1/8" [511mm]	1-3/8" [35mm]	11/16" [18mm]
L651 4' Nominal	44-1/8" [1121mm]	1-3/8" [35mm]	11/16" [18mm]
L652 8' Nominal	92-1/8" [2340mm]	1-3/8" [35mm]	11/16" [18mm]
L653 12' Nominal	140-1/8" [3559mm]	1-3/8" [35mm]	11/16" [18mm]

ORDERING INFORMATION

SAMPLE NUMBER: L651MB

Track	Finishes	Connectors (Order Separately)	Accessories (Order Separately)	Current Limiters (Order Separately)
L650= 2' **L651**= 4' **L652**= 8' **L653**= 12'	**P**=White **MB**=Black	**L900**=Outlet Box Cover **L901**=Live End Connector **L902**=Flexible Connector **L903**=Straight Connector **L904**=L Connector **L905**=T Connector **L906**=X Connector **L907**=Outlet Box for use with T-Bar ceiling **L908**=Mini Joiner **L909**=Floating Canopy and Connector **L950**=Cord and Plug Connector **L979**=Conduit Continuation Kit **L980**=Live End Conduit Adapter **DE600**=Dead End Finishes **P**=White **MB**=Black	**L951**=Wire Way Cover for Pendant Assembly Kit **L983**=T-Bar Attachment Clip **L992**=Pendant Kit Assembly **L48**=48" Steel Stem **L994**=Pendant Adapter Finishes **P**=White **MB**=Black	Current Limiter - End Feed **LC901CB120**=120W (1A @ 120V) **LC901CB300**=300W (2.5A @ 120V) **LC901CB600**=600W (5A @ 120V) **LC901CB960**=960W (8A @ 120V) **LC901CB1200**=1200W (10A @ 120V) Current Limiter - Center Feed **LC903CB120**=120W (1A @ 120V) **LC903CB300**=300W (2.5A @ 120V) **LC903CB600**=600W (5A @ 120V) **LC903CB960**=960W (8A @ 120V) **LC903CB1200**=1200W (10A @ 120V) Finishes **P**=White **MB**=Black

COOPER Lighting Solutions

TD518194EN
8/24/2016

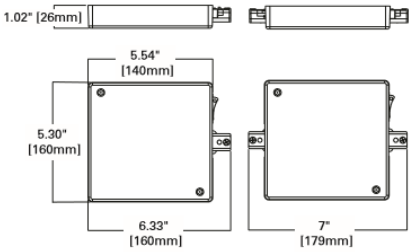
LC901, LC903 Current Limiter - End and Center Feeds

End-feed and Center-feed capable:
Five breaker sizes are available. Consult factory if other sizes are required. Can be utilized on hard or grid ceilings. Can be used with pendant suspended track. Breaker can be used as an on-off switch. Breaker features a "tripped" condition indicator. cULus Listed.

ORDERING INFORMATION

SAMPLE NUMBER: LC901CB120P

Feed Type	Circuit 1 Breaker	Finish
LC901= Halo Power-Trac 1-Circuit End Feed **LC903**= Halo Power-Trac 1-Circuit Center Feed	**CB120**=120W (1A @120V) **CB300**=300W (2.5A @120V) **CB600**=600W (5A @120V) **CB960**=960W (8A @120V) **CB1200**=1200W (10A @120V)	**P**=White **MB**=Black



Sample catalog number: LC901CB120P

Consult factory for Single Circuit Center-feed requiring two circuit breakers.

LC901
LC903

T24 Can be used to comply with California Title 24 High Efficacy requirements
T20 Certified to California Title 20 Appliance Database

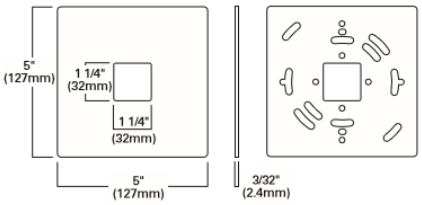
L900 - Outlet Box Cover

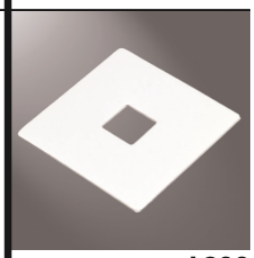
Can be used at any electrical feed connection point (Live, Straight, L, T or X). Drill guides on back for virtually all standard outlet boxes. Size: 5" sq. Screws included.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L900P

Connector	Finish
L900= Outlet Box Cover	**P**=White **MB**=Black





L900

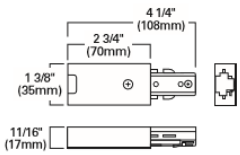
L901 - Live End Connector

To start a run.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L901P

Connector	Finish
L901= Live End Connector	**P**=White **MB**=Black



L901

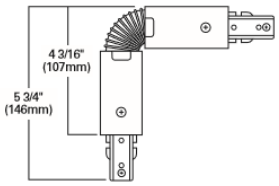
L902 - Flexible Connector

To connect two track sections at any angle up to 90° in either plane or wall to ceiling or pitched ceiling applications.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L902P

Connector	Finish
L902= Flexible Connector	**P**=White **MB**=Black



L902

COOPER Lighting Solutions

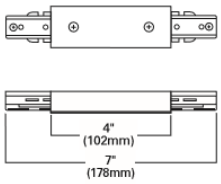
L903 - Straight Connector

To connect two track sections end-to-end. L903 differs from mini connector L908 in that it provides a center feed option and is longer.May be used as feed point.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L903P

Connector	Finish
L903= Straight Connector	**P**=White **MB**=Black



L903

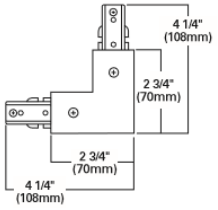
L904 - L Connector

To connect two track sections at a right angle. Field adjustable for either right hand or left hand application. May be used as feed point.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L904P

Connector	Finish
L904= L Connector	**P**=White **MB**=Black



L904

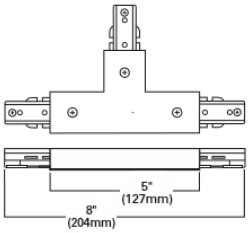
L905 - T Connector

To connect three track sections into a T configuration. Field adjustable for either right hand or left hand application. May be used as feed point.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L905P

Connector	Finish
L905= T Connector	**P**=White **MB**=Black



L905

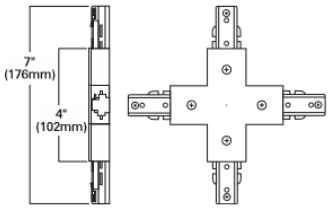
L906 - X Connector

To connect four track sections into a cross configuration. May be used as feed point.
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L906P

Connector	Finish
L906= X Connector	**P**=White **MB**=Black



L906

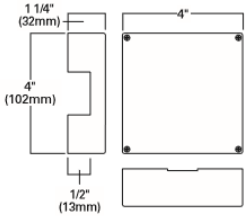
L907 - Outlet Box for use with T-Bar Ceiling

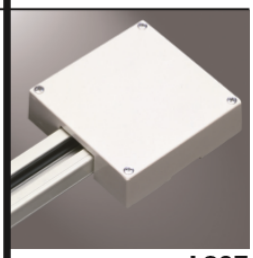
L901, L903, L904, L905 or L906 connector also required. 4"x 4" x 1 1/8".
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L907P

Connector	Finish
L907= Outlet Box for use with T-Bar Ceiling	**P**=White **MB**=Black





L907

L908 - Mini Joiner

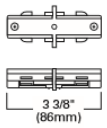
A low profile connector to cleanly and crisply join two straight track sections end-to-end. (Note: The L908 is not a feed point).

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L908P

Connector	Finish
L908= Mini Joiner	**P**=White **MB**=Black



L908

L909 - Floating Canopy and Connector

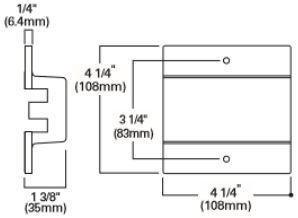
Track can be connected to existing outlet box located anywhere along the track. Comes with canopy cover, connector, dead-end and mounting hardware. 4 1/8" x 4 1/4" x 1 3/8".

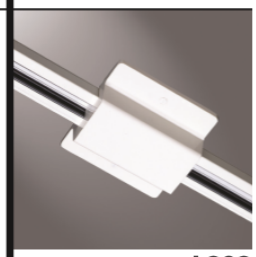
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L909P

Connector	Finish
L909= Floating Canopy and Connector	**P**=White **MB**=Black





L909

L950 - Cord and Plug Connector

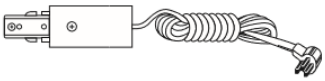
12' three-wire cord with grounded plug. Maximum capacity 10 AMP.

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L950P

Connector	Finish
L950= Cord and Plub Connector	**P**=White **MB**=Black



L950

L951 - Wire Way Cover for Pendant Assembly Kit

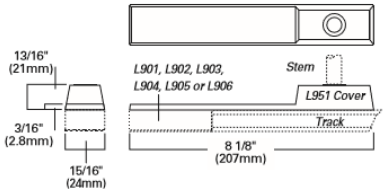
For track to be wired through stem(order one for each feed point used). For use with line connectors (L901, L902, L903, L904, L905 or L906) and pendant stem kit (L992)–order separately.

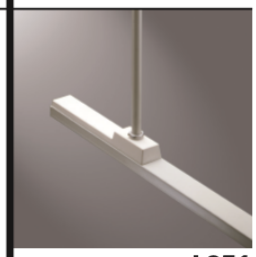
Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L951P

Connector	Finish
L951= Wire Way Cover for Pendant Assembly Kit	**P**=White **MB**=Black





L951

L979 - Conduit Continuation Kit

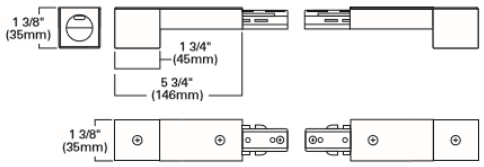
Consisting of one left feed and one right feed. To continue a run around obstructions. Designed to accept 1/2" trade size conduit fitting (not included).

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: L979P

Connector	Finish
L979= Conduit Continuation Kit	**P**=White **MB**=Black



L979

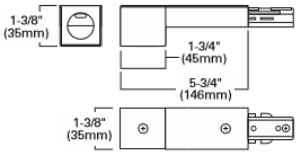
COOPER Lighting Solutions

Visual Terrain® www.visualterrain.net		PROJECT: Bentonville Ballroom CLIENT: Live Nation	**EQUIPMENT TYPE**
DATE: 10/23/2026	REVISION #	SUBMISSION: 100% Detail Design DOCUMENT #:	T50A
PAGE 471 OF 505	0	Equipment Page 5 of 6	

L980 - Live End Conduit Adapter

Designed to accept standard 1/2" trade size conduit fitting (not supplied). Use when feeding to track through surface conduit system.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L980P

Connector	Finish
L980= Live End Conduit Adapter	**P**=White **MB**=Black

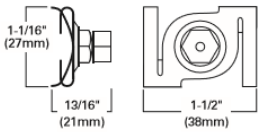
L980

L983 - T-Bar Attachment Clip

Allows track to be attached to inverted tee ceiling. Order as follows: 2 kits for 2' Trac; 2 kits for 4' Trac; 3 kits for 8' Trac and 4 kits for 12' Trac.

L986 Mini-T Bar Clip

For mounting Trac on suspended ceilings with mini-grid (9/16" wide) system.



ORDERING INFORMATION

SAMPLE NUMBER: L983P

Connector	Finish
L983= T-Bar Attachment Clip **L986**= Mini T-Bar Clip	**P**=White **MB**=Black

L983

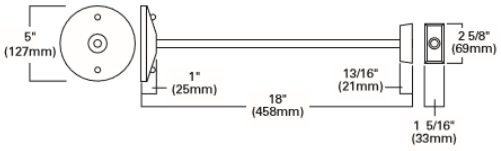
L992 - Pendant Kit Assembly

Order 2 kits for 2' Trac; 2 kits for 4' Trac; 3 kits for 8' Trac; and 4 kits for 12' Trac. Includes one 18" threaded steel stem, canopy andmounting hardware.

L48 48" Steel Stem

For additional length with L992. Can be field cut.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L992P

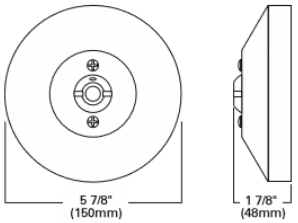
Connector	Finish
L992= Pendant Kit Assembly	**P**=White **MB**=Black

L992

L994 - Pendant Adapter

For installing pendant mounted Power-Trac on sloped ceiling. For use with L992.

Color codes: P (White), MB (Black)



ORDERING INFORMATION

SAMPLE NUMBER: L994P

Connector	Finish
L994= Pendant Adapter	**P**=White **MB**=Black

L994

DE600 - Dead End

Color codes: P (White), MB (Black)

ORDERING INFORMATION

SAMPLE NUMBER: DE600P

Connector	Finish
DE600= Dead End	**P**=White **MB**=Black

DE600

COOPER Lighting Solutions

Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

Specifications and dimensions subject to change without notice.

EQUIPMENT

MANUFACTURER	ETC
CATALOG NUMBER	Source Four Mini: 4ML-30-80-120-T
TOTAL WATTS	14
VOLTAGE	120VAC
MOUNTING	Track
WEIGHT	2.4 lb
DIMENSIONS	9.69" x 5.25" x 9.82"
FINISH	Black
RATING	IP40
LISTING	ETL

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	671
ANTICIPATED LIFE	35000

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

TYPE	Lens Tube
MANUFACTURER	ETC
CATALOG NUMBER	**4M19LT**
TYPE	Color Frame
MANUFACTURER	ETC
CATALOG NUMBER	**4MCF**
TYPE	Pattern Holder
MANUFACTURER	ETC
CATALOG NUMBER	**4MPH**

Track mount adjustable spot light with one (1) LED lighting source, 671 delivered lumens, 3000K color engine, 80+ CRI, 19° optic and integral driver. Spot light should operate on 120VAC voltage and be supplied with a line voltage dimmer control option and include a minimum 5-year warranty with a 35000 hour anticipated life. Spot light to have black finish. Spot light to be rated for IP40 or equivalent. Spot light should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	LINE VOLTAGE DIMMER
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

T51
Source Four Mini: 4ML-30-80-120-T (fixture) + 4M19LT (lens tube) + 4MCF (color frame) + 4MPH (pattern holder)

ETC

Source Four Mini LED

Source Four Mini Series

Type(s)

Project

Date

Notes

GENERAL INFORMATION

The Source Four Mini LED can go where no full-sized Source Four has gone before. ETC's 12 W Source Four Mini LED features the same crisp optics, user-friendly functionality, and sleek look of the legendary Source Four fixture, but in a compact format at a fraction of the size.

The Source Four Mini LED has four field-angle choices and comes in a portable version for mounting with a clamp, a canopy-mount, or track-mount design. Surprisingly bright for its size, the Mini LED offers crystal-clear image projection and a bright, even field.

APPLICATIONS

- Museums
- Retail
- Restaurants
- Hospitality
- Theatres

FEATURES

- Rugged, die-cast fixture body
- 19°, 26°, 36°, and 50° interchangeable lens tubes
- Long-life dimmable white LED source available in a wide variety of color temperatures and color rendering levels
- Three-plane shutters
- Multiple accessories available for color, pattern, and filtering
- Available for portable, canopy, and track mounting
- F-Drive compatible versions available
- Custom paint colors available; contact ETC

Source Four Mini LED Body Only - Order Lens Tube Separately

MODEL	COLOR TEMP	CRI	VOLTAGE	MOUNTING	COLOR
4ML - Source Four Mini LED	**27 -** 2700 K **30 -** 3000 K **40 -** 4000 K **50 -** 5000 K	**80 -** Standard **90 -** Gallery -Gallery available with 2700 K and 3000 K options. -Standard available in 3000 K, 4000 K and 5000 K options	**120 -** 120 V **230 -** 230 V **FD -** F-Drive Compatible	**OT -** OneTrack* **T -** DataTrack / EUTRAC** **TAD1 -** HALO Miniature Trac* **TGLB -** Global Trac Pro* **C -** Canopy **P -** Portable **PU -** Portable (UK 13A Plug) **PE -** Portable (EU Schuko Plug) -120-P comes with an Edison Plug - F-Drive compatible available in C and P only	**BLANK -** Black **1 -** White **8 -** Custom
			120-TGLB-		

To complete the form, simply select an option at the bottom of each column to populate the last row with your desired model number.

Color Options: Fixtures ship standard in black or white. For additional colors, please contact ETC.

*Only available in 120 V

**Please use our new and improved OneTrack for all new installations. DataTrack luminaires are intended for legacy installations only.

PRODUCT SPECIFICATIONS

Source

LED details	Lumileds 1204HD
Max field lumens	671 (5000 K, 50°)
Lumens per watt	43.0
L70 rating (hours to 70% output)	35,000

LED Color Temperature Data

Available color temperature options	2700 K / 3000 K / 4000 K / 5000 K
CRI options	90 CRI - 2700 K and 3000 K 80 CRI - 3000 K, 4000 K and 5000 K
Red shift	No

Optical

Field angle options	19° / 26° / 36° / 50°
Pattern projection	Yes
Pattern size	E (37.5 mm with a 25.4 mm image area). Holder included
Front accessory slot	Dual, captive accessory slots with 70 mm (2.75 in) media frame (included)

Electrical

Voltage range	100–120 V 50/60 Hz 230–240 V 50/60 Hz
Power cord length (portable VAC variant only)	190 cm (75 in)
Track adapter (Track variant only)	120 V - OneTrack or DataTrack 230 V - EUTRAC 3-circuit track adapter GLOBAL Trac Pro (GA69) or HALO Miniature Trac compatible adapters available on request. Note: HALO Miniature Trac adapter (AD1) is not compatible with Lazer-Trac or TEK track systems
Wattage typical/max	12 W Typical / 14 W Max
Inrush (first half-cycle)	120 V - <1 A 230 V - <1 A
Dimming compatability	Forward and reverse phase (120/230 VAC versions)

Thermal

Ambient operating temp	0°C to 40°C (32°F to 104°F)
Fan (controllable)	No fan
BTUs/hour	40.95 typical / 47.77 max

F-Drive Variant Details

Approved drivers	F-Drive R12 CC150 Output Card Model Number: FD-ROC-CC150 F-Drive W1 CC Wall Mount Model Number: FDW1CCD and FDW1ECCD
Maximum units per approved driver	FD-ROC-CC150: four (4) FD-W1-CCD: four (4) FD-W1E-CCD: four (4)
Luminaire operating current	350 mA
Input type	RJ45 in and thru connector Minimum required conductor gauge 23 AWG / 0.25 mm²
Control	DMX control via F-Drive compatible models only via R12 CC150 or W1 CC drivers
Complete driver data	etcconnect.com/F-Drive

Physical

Materials	Die-cast aluminum (A380 grade)
Color options	Black, white, or custom color
Mounting options	Track, Portable, or Canopy
Track adapter/Canopy color	Color matched to fixture
IP rating	IP20
Weight	Track Mount: 1.1 kg (2.4 lb) Portable: 1.2 kg (2.6 lb) Canopy: 1.2 kg (2.6 lb)
Included accessories	E-size pattern holder Media frame Included with lens tube (both sold separately)

Warranty

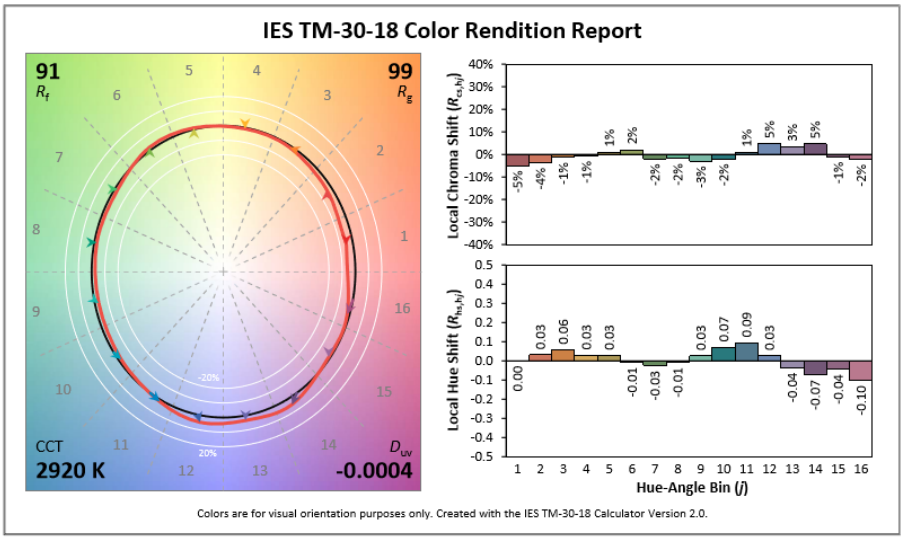
Fixture	5 years
LED array	10 years

Approved Regulatory Standards

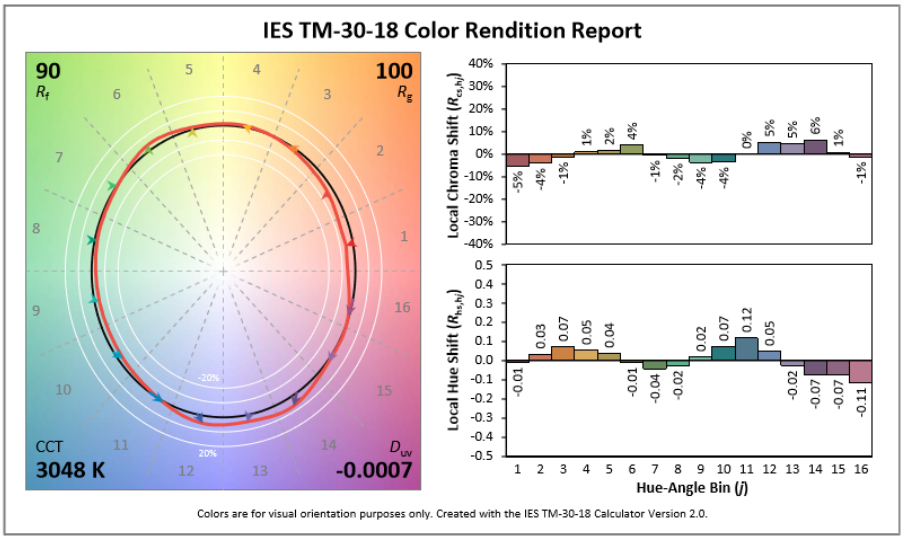
All versions	cETLus Listed CE Compliant UKCA Compliant
Portable version (including F-Drive and standard models)	Conforms to ANSI/UL STD.153 Certified to CSA STD. C22.2 No: 250.4
Track versions	Conforms to ANSI/UL STD.1574 Certified to CSA STD. C22.2 No: 9.0
Canopy version	Conforms to ANSI/UL STD.1598 Certified to CSA STD. C22.2 No: 250

COLOR METRIC INFO

SOURCE FOUR MINI LED 2700 K GALLERY (90 CRI) TM-30-18

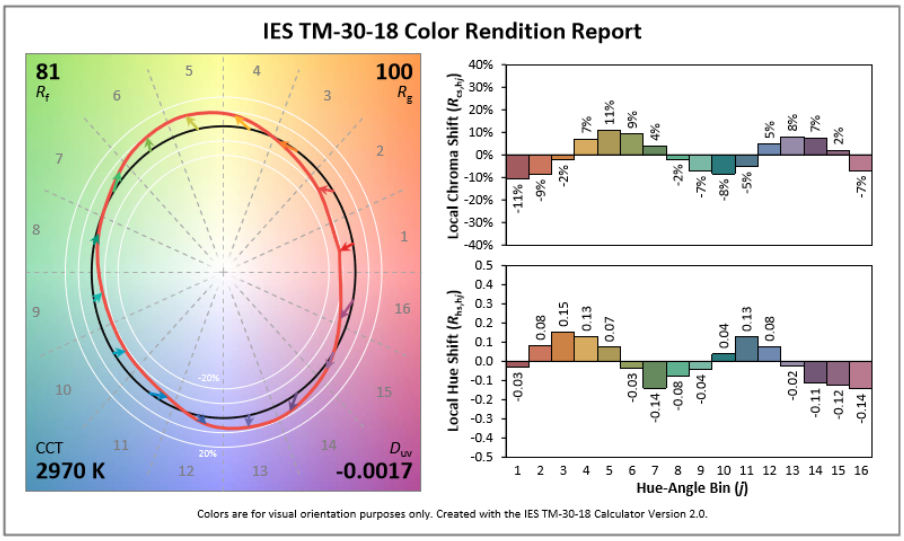


SOURCE FOUR MINI LED 3000 K GALLERY (90 CRI) TM-30-18

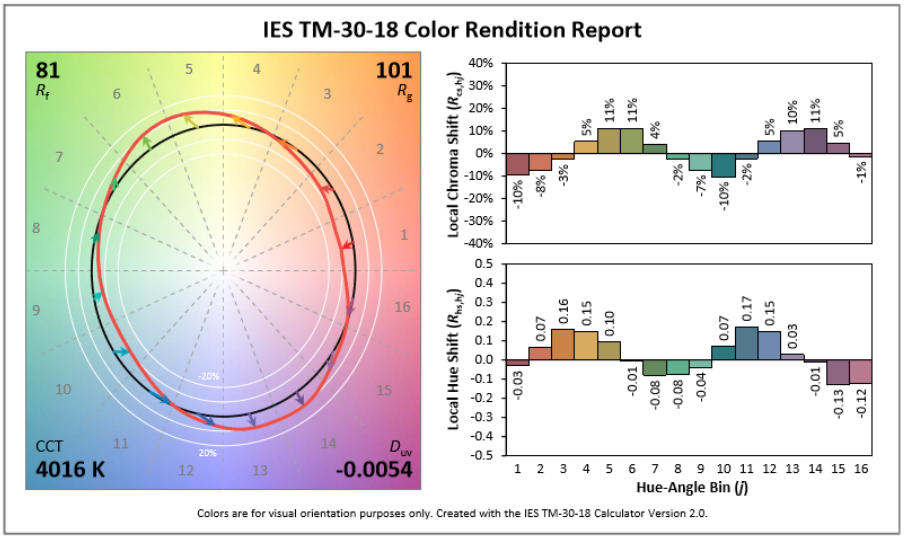


COLOR METRIC INFO

SOURCE FOUR MINI LED 3000 K (80 CRI) TM-30-18

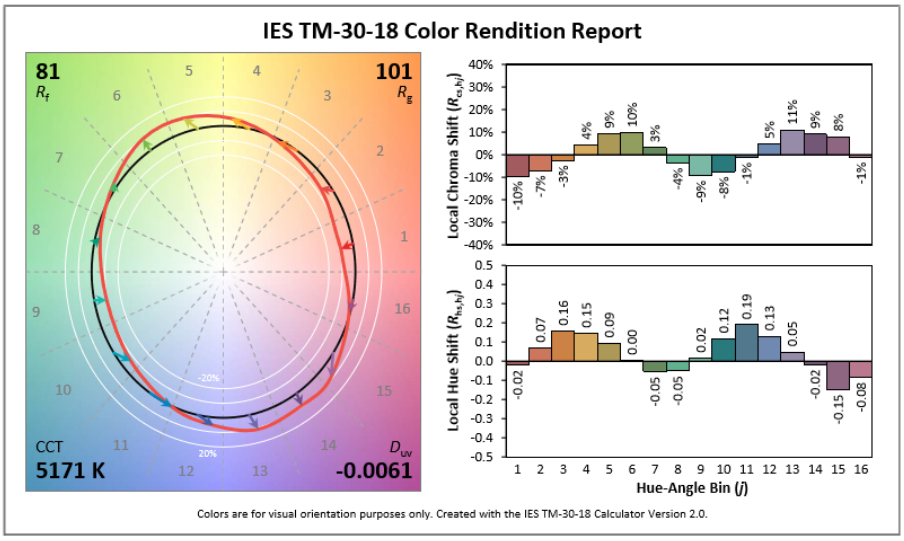


SOURCE FOUR MINI LED 4000 K (80 CRI) TM-30-18



COLOR METRIC INFO

SOURCE FOUR MINI LED 5000 K (80 CRI) TM-30-18



PHOTOMETRY

Array	Lens Tube	Candela	Delivered Lumens	Field Lumens	Beam Lumens	Power Consumption	Efficacy (lpw)
2700 K / 90 CRI	19°	7,557	484	472	370	15.6	31.0
2700 K / 90 CRI	26°	4,215	491	479	373	15.6	31.5
2700 K / 90 CRI	36°	2,309	506	495	410	15.6	32.4
2700 K / 90 CRI	50°	1,372	507	496	361	15.6	32.5
3000 K / 90 CRI	19°	8,502	544	531	416	15.6	34.9
3000 K / 90 CRI	26°	4,661	553	539	425	15.6	35.4
3000 K / 90 CRI	36°	2,584	566	555	459	15.6	36.3
3000 K / 90 CRI	50°	1,543	571	558	407	15.6	36.6
3000 K / 80 CRI	19°	9,527	610	595	466	15.6	39.1
3000 K / 80 CRI	26°	5,240	617	604	481	15.6	39.6
3000 K / 80 CRI	36°	2,896	635	622	515	15.6	40.7
3000 K / 80 CRI	50°	1,728	639	625	455	15.6	41.0
4000 K / 80 CRI	19°	9,399	602	587	460	15.6	38.6
4000 K / 80 CRI	26°	5,197	611	595	464	15.6	39.2
4000 K / 80 CRI	36°	2,854	626	613	507	15.6	40.1
4000 K / 80 CRI	50°	1,703	630	616	449	15.6	40.4
5000 K / 80 CRI	19°	10,000	641	625	489	15.6	41.1
5000 K / 80 CRI	26°	5,519	651	634	493	15.6	41.7
5000 K / 80 CRI	36°	3,041	667	653	540	15.6	42.8
5000 K / 80 CRI	50°	1,814	671	656	478	15.6	43.0

ORDERING INFORMATION

Source Four Mini LED Lens Tubes

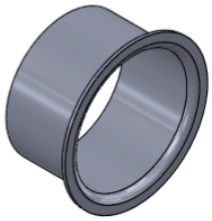
MODEL	DESCRIPTION	
4M19LT	19° Source Four Mini Lens Tube (black)	
4M26LT	26° Source Four Mini Lens Tube (black)	
4M36LT	36° Source Four Mini Lens Tube (black)	
4M50LT	50° Source Four Mini Lens Tube (black)	
COLOR OPTIONS (add suffix below to above model after "LT")		
-1	White	
-8	Custom	

Source Four Mini Accessories

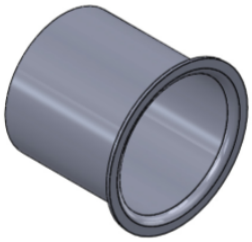
MODEL	DESCRIPTION	
4MCC	S4 Mini C-Clamp, Black*	
4MPH	Pattern holder	
4MCF	Color frame	
4MD	Donut	
4MTH	Top hat	
4MTHS	Top hat short	
4MHH	Half hat	
4MHHS	Half hat short	

*Source Four Mini LED portable comes with no clamp included. Please choose from the above clamps if one is required.

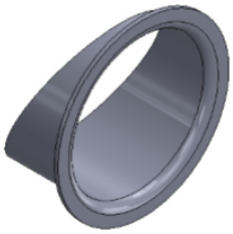
4MTHS - TOP HAT SHORT



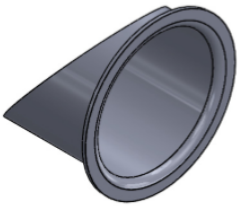
4MTH - TOP HAT



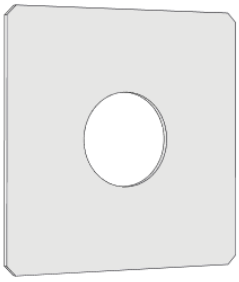
4MHHS - HALF HAT SHORT



4MHH - HALF HAT



4MD - DONUT

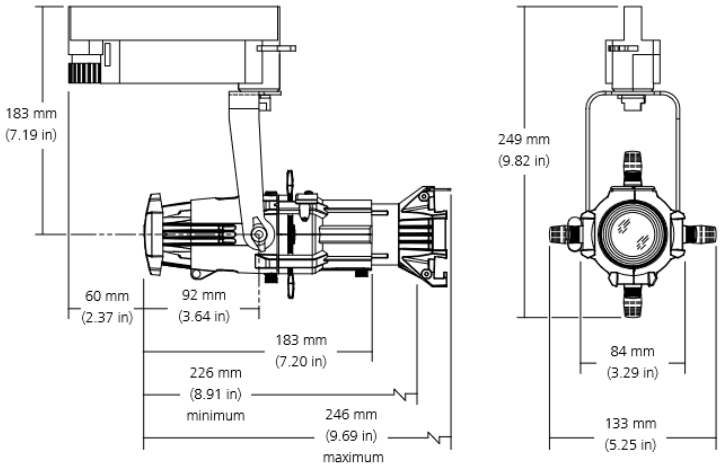


PHYSICAL

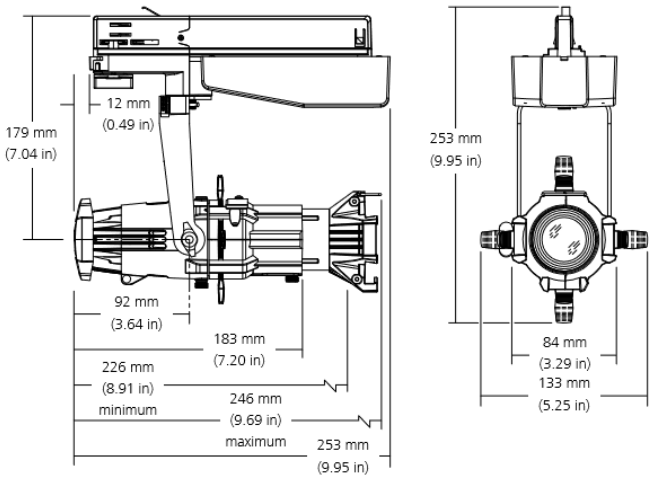
Source Four Mini LED Weights and Dimensions

	HEIGHT		WIDTH		DEPTH		WEIGHT		SHIPPING WEIGHT	
	in	mm	in	mm	in	mm	lb	kg	lb	kg
Portable	9.87	251	5.25	133	9.69	246	2.6	1.2	3.8	1.7
F-Drive Portable	9.87	251	5.25	133	9.69	246	1.6	0.8	2.8	1.3
Canopy	8.18	208	5.25	133	9.69	246	2.6	1.2	3.7	1.7
F-Drive Canopy	8.18	208	5.25	133	9.69	246	2.2	1.0	3.3	1.5
OneTrack	9.95	253	5.25	133	9.69	246	2.4	1.1	3.6	1.6
DataTrack / EUTRAC Mount	9.82	249	5.25	133	9.69	246	2.4	1.1	3.6	1.6

SOURCE FOUR MINI LED DATATRACK MOUNT

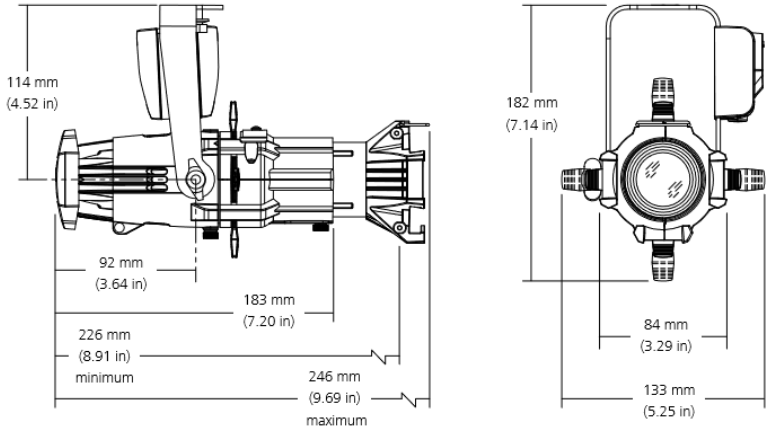


SOURCE FOUR MINI LED ONETRACK MOUNT

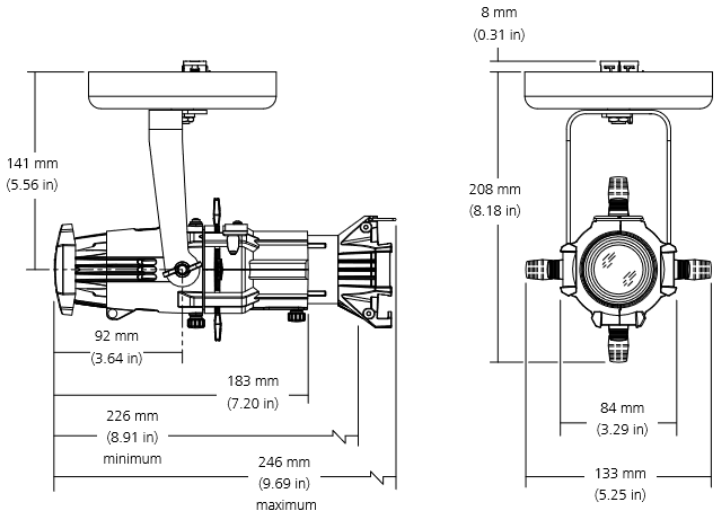


PHYSICAL

SOURCE FOUR MINI LED PORTABLE - F-DRIVE

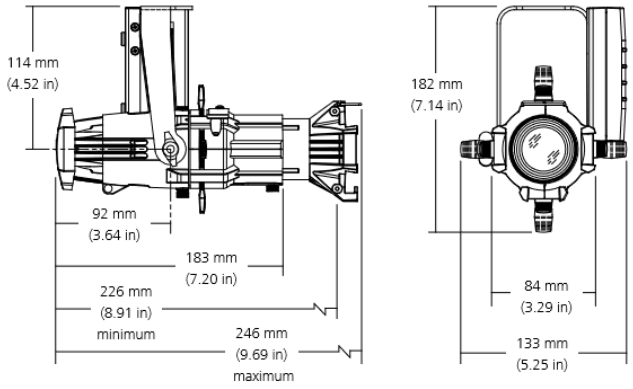


SOURCE FOUR MINI LED CANOPY - F-DRIVE

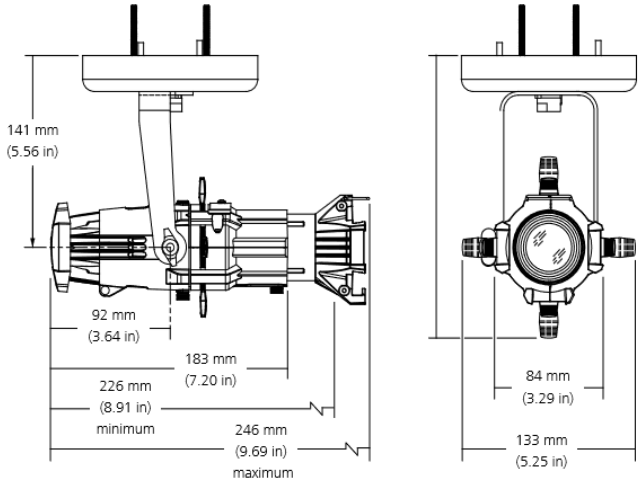


PHYSICAL

SOURCE FOUR MINI LED PORTABLE



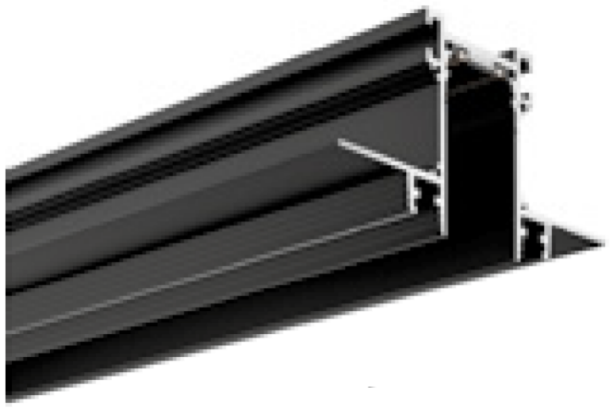
SOURCE FOUR MINI LED CANOPY



Corporate Headquarters ▪ Middleton, WI USA
Global Offices ▪ London, UK ▪ Rome, IT ▪ Holzkirchen, DE ▪ Paris, FR ▪ Hong Kong
Dubai, UAE ▪ Singapore ▪ New York, NY ▪ Orlando, FL ▪ Los Angeles, CA ▪ Austin, TX
©2024 ETC. All Rights Reserved. All product information and specifications subject to change. Rev W 2024-09
*Trademark and patent info: etcconnect.com/IP.▪ Third-party license agreement info: etcconnect.com/licenses

etcconnect.com

EQUIPMENT	
MANUFACTURER	XAL
CATALOG NUMBER	Move1.2-RTL-BL-48V-010V-ST-LENGTH
TOTAL WATTS	
VOLTAGE	48
MOUNTING	Recessed
WEIGHT	
DIMENSIONS	2417mm x 4.2" x 2.2"
FINISH	TBD
RATING	IP
LISTING	
SOURCE	
POWER SUPPLY	
TYPE	Remote
PROVIDED BY	
ACCESSORIES	



Recessed mount fixed track should operate on 48 voltage with 0-10v circuit.Track to have tbd finish. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. System to be mounted as indicated on plans. System components to be fabricated by the same manufacturer, e.g. track heads, track, connectors, hardware, etc, to ensure compatibility.

CONTROL	
PROTOCOL	0-10V
INTENT	

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

MOVE IT 25 system

trimless / surface / suspended

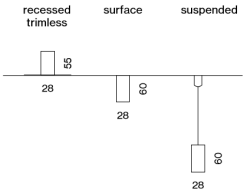
EN Extruded aluminium profile with 28 mm width groove; for trimless installation in plasterboard ceilings (wall or ceiling mounting) with 12.5 mm ceiling thickness; or for wall-/ ceiling surface mounting or suspended mounting (cable suspension, height adjustment without tools, incl. black feed); optional indirect light component for additional accentuation of the ceiling; for lighting systems; linear, 90° angle connectors or 90° CURVE segment; node connectors, up to 6 profile connection options; with power track profile for take off of supply voltage and DALI signal; surf. anod. or powder coated; insets can be installed flexibly and without tools by means of magnetic holders + locking; sound absorbing accessories available

DE Aluminiumstrangpressprofil mit 28 mm Fugenbreite; für randlosen Einbau in Gipskartondecken (Wand- oder Deckenmontage) mit 12,5 mm Deckenstärke; oder für Wand-/ Deckenanbaumontage oder für abgehängte Montage (Seilabhängung, werkzeuglose Höhenverstellung, inkl. schwarzer Einspeiseleitung); optional indirekte Lichtkomponente für zusätzliche Akzentuierung der Decke; für Lichtsysteme; linear, 90° Winkelverbinder oder 90° CURVE Element; Knotenverbinder, bis zu 6 Profilanschlussmöglichkeiten; mit Stromschienenprofil für Abnahme von Versorgungsspannung und DALI Signal; Oberfl. elox. bzw. pulverbeschichtet; flexible und werkzeuglose Montage der Einsätze durch Magnethalterung + Verriegelung; schallabsorbierendes Zubehör erhältlich

Quickinfo

3000 K
CRI ≥ 90, 2 SDCM
up to 118 lm/W
L80 @ 50 000 h
non DIM, DALI-2

Types



connectors

node

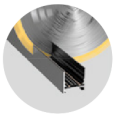
corner

curve

Colours

standard

xal.com/colours



custom cut on building site

acoustic elements

Order options

CONTROL

non DIM	1
DALI-2	3

MATERIAL COLOUR

● jet black RAL 9005

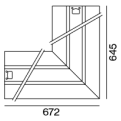
Options on request

CONNECTOR

T-connector
X-connector

INSTALLATION TRACK

acoustic soft ceilings



MOVE IT 25 trimless

DALI-2 | 48V | TRACK max. 6,67 A | pending | CB pending

INSTALLATION TRACK

L (mm)		ORDER CODE
617	channel	050-72020▫8
1217	channel	050-72040▫8
2417	channel	050-72080▫8
3622	channel	050-72090▫8
cust. cut	channel (non DIM)	E83031····8
cust. cut	channel (DALI-2)	E83041····8
672x645	channel corner* 90°	050-72010▫8
661x661	channel corner* ceiling to wall 90°	050-72011▫8

*incl. electrical connector set

Accessories

END CAPS

TYPE	ORDER CODE
end caps (pair)	050-7200008

BLIND COVER

L (mm)	ORDER CODE
1217	050-7004008
2417	050-7008008
3622	050-7009008
custom cut	E83000····8B

blind cover can be shortened as desired

CONNECTOR SET

TYPE	ORDER CODE
linear connector (non DIM, DALI-2)	050-2031130
linear connector flexible	050-20321▫0
mechanical linear connector (pair)	050-2011110

POWER FEEDER UNIT

TYPE	ORDER CODE
non DIM 2×2,5 mm²	050-2020110
DALI-2 2×2,5 + 2×0,5 mm²	050-2020130

cable length 500 mm

Electrical accessories

see following pages

Rev. 004/2025-02

Order options

CONTROL

non DIM	1
DALI-2	3

MATERIAL COLOUR INSTALLATION TRACK

● jet black RAL 9005	8
◒ traffic white 9016 / jet black 9005	P
◒ gold dust 260-M / jet black 9005	G
special colours*	X

*inside always in black

MATERIAL COLOUR NODE CONNECTOR

○ traffic white RAL 9016	7
● jet black RAL 9005	8
special colours	X

MATERIAL COLOUR NODE LTX / END CAP

● jet black RAL 9005	8
◒ traffic white 9016 / jet black 9005	P
special colours	X

MATERIAL COLOUR ACCESSORIES

○ traffic white RAL 9016	7
● jet black RAL 9005	8

MATERIAL COLOUR CABLE SUSPENSION

chrome	0
black	8

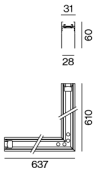
NODE CONNECTOR MOUNTING TYPE

surface*	1
1500 mm cable susp. chrome	3
1500 mm cable susp. black	4

*only for L/T/X

MOVE IT 25 surface / suspended

DALI-2 · 48V · TRACK max. 6,67 A · pending · CB pending

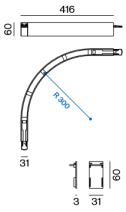


INSTALLATION TRACK / BLIND COVER

L (mm)		ORDER CODE
620	channel	050-73020
1220	channel	050-73040
2420	channel	050-73080
3625	channel	050-73090
cust. cut	channel (non DIM)	E83051
cust. cut	channel (DALI-2)	E83061
637x610	channel corner* 90°	050-73010
666x666	channel corner* ceiling to wall 90°	050-73011

*incl. electrical connector set

1217	blind cover	050-7004008
2417	blind cover	050-7008008
3622	blind cover	050-7009008
cust. cut	blind cover	E83000 · · · · 8B



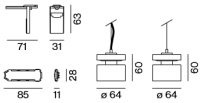
CURVE CONNECTOR

TYPE	ORDER CODE
mechanical & electrical R 300 mm	050-730303
mechanical R 300 mm	050-730311

Accessories

END CAPS

TYPE	ORDER CODE
end caps (pair)	050-730000



NODE CONNECTOR

TYPE	ORDER CODE
NODE surface mounted	050-203333
NODE surface mounted incl. feeder	050-202243
NODE cable suspension 1500 mm	050-20331
NODE cable susp. 1500 mm incl. feeder	050-20222
NODE end cap* incl. electrical connector	050-730010

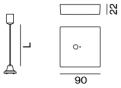
*order for every node connection (channel to node) 1 end cap

CONNECTOR SET

TYPE	ORDER CODE
mechanical linear conn. incl. 1500 mm cable susp.	050-201131
mechanical linear connector surface	050-2011410
mechanical & electrical linear connector	050-2031230

POWER FEEDER UNIT

TYPE	L (mm)	ORDER CODE
non DIM 2×2,5 mm²	2000	050-2022110
DALI-2 2×2,5 + 2×0,5 mm²	2000	050-2022130
non DIM 2×2,5 mm²	4000	050-2024110
DALI-2 2×2,5 + 2×0,5 mm²	4000	050-2024130



CEILING FASTENER / CABLE SUSPENSION / CANOPY / WALL

TYPE	L (mm)	ORDER CODE
ceiling fastener	67	050-204111
cable suspension*	1500	005-215211
canopy		005-231171
wall mounting accessory		050-2044118

*use every 1200 mm

Electrical accessories

see following pages

Acoustic elements

see following pages

Rev. 010/2025-02

EQUIPMENT

MANUFACTURER	XAL
CATALOG NUMBER	MOVEINS-JUST32-BL-30K-C90-010V -0400LM
TOTAL WATTS	5.5
VOLTAGE	48
MOUNTING	Track
WEIGHT	
DIMENSIONS	3” x 1.3” x 2.9”
FINISH	
RATING	IP
LISTING	

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	90+
LUMEN OUTPUT	411
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

TYPE	Honeycomb Louver
MANUFACTURER	XAL
CATALOG NUMBER	007-1965178

Track mount adjustable spot light with one (1) LED lighting source, 411 delivered lumens, 3000K color engine, 90+ CRI, 17°-43° optic and remote driver. Spot light should operate on 48 voltage and be supplied with a tbd control option. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation.

CONTROL

PROTOCOL	TBD
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

Order options

COLOUR TEMPERATURE

2700 K	9
3000 K	0
4000 K	1
colour warm dim. 2000–3000 K*	
tunable white 1800–3000 K**	
tunable white 2700–6500 K**	

*DALI-2 **DALI-2 DT8

CONTROL

non DIM	1
DALI-2	3

MATERIAL COLOUR

traffic white RAL 9016	7
jet black RAL 9005	8
special colours	X

BEAM ANGLE JUST 45

medium 23°	M
flood 44°	F

BEAM ANGLE JUST 55

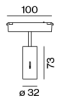
spot 16°	S
medium 23°	M
flood 37°	F

Options on request

OPTICAL ACCESSORIES

elliptical sculpture foil
snoot
colour filter (red, blue, green, etc.)

only for JUST 32 focus



JUST 32 focus 17–43°

CRI ≥90 · DALI 1 ADDR. · 48 V · pending · pending · CB pending

SPOTLIGHT

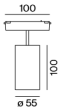
INSET POWER	LUMINOUS FLUX	ORDER CODE
5.5 W	411 lm	050-0111

JUST 45

CRI ≥90 · DALI 1 ADDR. · 48 V · pending · pending · CB pending

SPOTLIGHT

INSET POWER	LUMINOUS FLUX	ORDER CODE
6.0 W super spot 8°	285 lm	050-0131 3 V
10.9 W	960 lm	050-0131
12 W CWD 2000–3000 K	430 lm	050-0131E3
11 W TW 1800–3000 K	555 lm	050-0131L3
11 W TW 2700–6500 K	683 lm	050-0131D3



JUST 55

CRI ≥90 · DALI 1 ADDR. · 48 V · pending · pending · CB pending

SPOTLIGHT

INSET POWER	LUMINOUS FLUX	ORDER CODE
12.7 W	1330 lm	050-0143 3
19.1 W	1820 lm	050-0142 3

Optical accessories

HONEYCOMB LOUVER

TYPE	Ø·H (mm)	ORDER CODE
JUST 32 focus	30·4	007-1965178
JUST 45	42·3	007-1965188
JUST 55	50·3	007-1965598

OVAL LENS

TYPE	Ø·H (mm)	ORDER CODE
JUST 45	42·3	007-1965880
JUST 55	50·3	007-1965890

SOFT LENS

TYPE	Ø·H (mm)	ORDER CODE
JUST 45	42·3	007-1965980
JUST 55	50·3	007-1965990

WALLWASHER LENS

TYPE	Ø·H (mm)	ORDER CODE
JUST 45	42·3	007-1965780
JUST 55	50·3	007-1965790

INSET POWER in watts is the current consumption excluding any ballast
LUMINOUS FLUX value calculated for 3000 K, CRI ≥ 90, colour white, lens flood 2700 K -5 %, 4000 K +5%

Rev. 006/2024-09

EQUIPMENT

MANUFACTURER	LIGMAN Lighting Co.,Ltd
CATALOG NUMBER	HA-60037-S-E-9530-ND-00
TOTAL WATTS	8
VOLTAGE	220-240
MOUNTING	In-grade
WEIGHT	0.7 kg
DIMENSIONS	120mm x 120mm x 150mm
FINISH	Stainless Steel
RATING	IP67
LISTING	IK10

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	95+
LUMEN OUTPUT	294
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

In-grade mount adjustable wall wash with one (1) LED lighting source, 294 delivered lumens, 3000K color engine, 95 + CRI, 12° x 50° optic and integral driver. Wall Wash should operate on 220-240 voltage and be supplied with a 0-10v control option and include a minimum 10-year warranty. Wall wash to have stainless steel finish. Wall Wash to be rated for IP67 or equivalent. Wall Wash should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

LIGMAN

HARRIER

Outdoor | **In-ground luminaires**

IP67 IK10

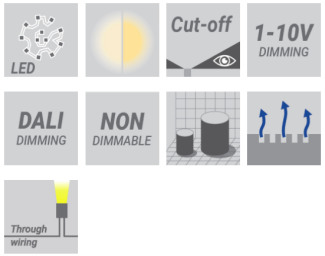
Complete, flexible, competitive accent and floodlight in-grounds. The lighting industry's leading quality low-cost in-ground fixture family.

microPrism™

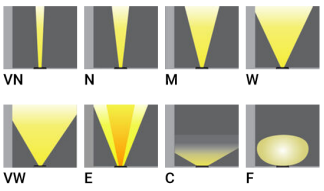
Luminaire Structure

- Die-cast aluminium housing
- Pre-treated before powder coating ensuring high corrosion resistance
- 6 mm thick front ring in grade 316 stainless steel or aluminium
- Single cable entry, through wiring upon request
- Stainless steel fasteners in grade 316
- Durable silicone rubber gasket
- High-efficiency PMMA lens
- Clear or frosted toughened glass
- Integral control gear for HA-60036, HA-60037, HA-60049, HA-60050, HA-60196, HA-60197, HA-60209, HA-60215, HA-60295, HA-60296, HA-60305, HA-60306
- Remote driver, remote box (IP-rated) and recessing box are included for HA-60385, HA-60386, HA-60395, HA-60396
- Recessing box in high-density polyethylene is included
- Suitable for walk-over with a maximum load of 200 kg

Feature

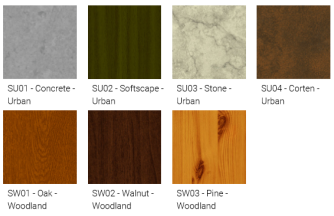


Optic



Product colour

Special finishes upon request



We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

Technical information

	Model number	Light source	Power	Lumen	Optic	CCT / CRI	Dimming type	Weight
Integral control gear - With recessing box - Round - Aluminium frame								
HARRIER 3	**HA-60050-A**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.4 kg
HARRIER 3	**HA-60295-A**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
Integral control gear - With recessing box - Round - Stainless steel frame								
HARRIER 3	**HA-60295-S**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
Integral control gear - With recessing box - Square - Aluminium frame								
HARRIER 4	**HA-60306-A**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
Integral control gear - With recessing box - Square - Stainless steel frame								
HARRIER 4	**HA-60306-S**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
Integral control gear - With recessing box - Round - Aluminium frame								
HARRIER 1	**HA-60036-A**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.5 kg
HARRIER 1	**HA-60037-A**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.5 kg
Integral control gear - With recessing box - Round - Stainless steel frame								
HARRIER 1	**HA-60036-S**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.7 kg
HARRIER 1	**HA-60037-S**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.7 kg
HARRIER 3	**HA-60050-S**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.6 kg
Integral control gear - With recessing box - Square - Aluminium frame								
HARRIER 2	**HA-60196-A**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.5 kg
HARRIER 2	**HA-60197-A**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.5 kg
HARRIER 4	**HA-60209-A**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
HARRIER 4	**HA-60215-A**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.4 kg
HARRIER 4	**HA-60305-A**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
Integral control gear - With recessing box - Square - Stainless steel frame								
HARRIER 2	**HA-60196-S**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.7 kg
HARRIER 2	**HA-60197-S**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.7 kg
HARRIER 4	**HA-60209-S**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
HARRIER 4	**HA-60215-S**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.6 kg
HARRIER 4	**HA-60305-S**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
With recessing box / driver - Round - Aluminium frame								
HARRIER 3	**HA-60049-A**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg

We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

HARRIER 3	**HA-60296-A**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
With recessing box / driver - Round - Stainless steel frame								
HARRIER 3	**HA-60049-S**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
HARRIER 3	**HA-60296-S**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
With remote box IP-rated / remote driver / recessing box - Round - Aluminium frame								
HARRIER 1	**HA-60385-A**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
HARRIER 1	**HA-60386-A**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
With remote box IP-rated / remote driver / recessing box - Round - Stainless steel frame								
HARRIER 1	**HA-60385-S**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg
HARRIER 1	**HA-60386-S**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg
With remote box IP-rated / remote driver / recessing box - Square - Aluminium frame								
HARRIER 2	**HA-60395-A**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
HARRIER 2	**HA-60396-A**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
With remote box IP-rated / remote driver / recessing box - Square - Stainless steel frame								
HARRIER 2	**HA-60395-S**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg
HARRIER 2	**HA-60396-S**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg

Accessory

	Anti slip glass **A60212**	Connector IP68 5 Pin Power + Signal **A613191**	Connector IP68 3 Pin Power **A62591**	DALI Control System **Control-DALI**
HA-60036-A		·	·	
HA-60036-S		·	·	
HA-60037-A		·	·	
HA-60037-S		·	·	
HA-60049-A	·	·	·	·
HA-60049-S	·	·	·	·
HA-60050-A	·	·	·	·
HA-60050-S	·	·	·	·
HA-60196-A		·	·	
HA-60196-S		·	·	
HA-60197-A		·	·	
HA-60197-S		·	·	
HA-60209-A	·	·	·	·
HA-60209-S	·	·	·	·
HA-60215-A	·	·	·	·
HA-60215-S	·	·	·	·
HA-60295-A	·	·	·	·
HA-60295-S	·	·	·	·
HA-60296-A	·	·	·	·
HA-60296-S	·	·	·	·
HA-60305-A	·	·	·	·
HA-60305-S	·	·	·	·
HA-60306-A	·	·	·	·

We reserve the right to make technical and design changes.

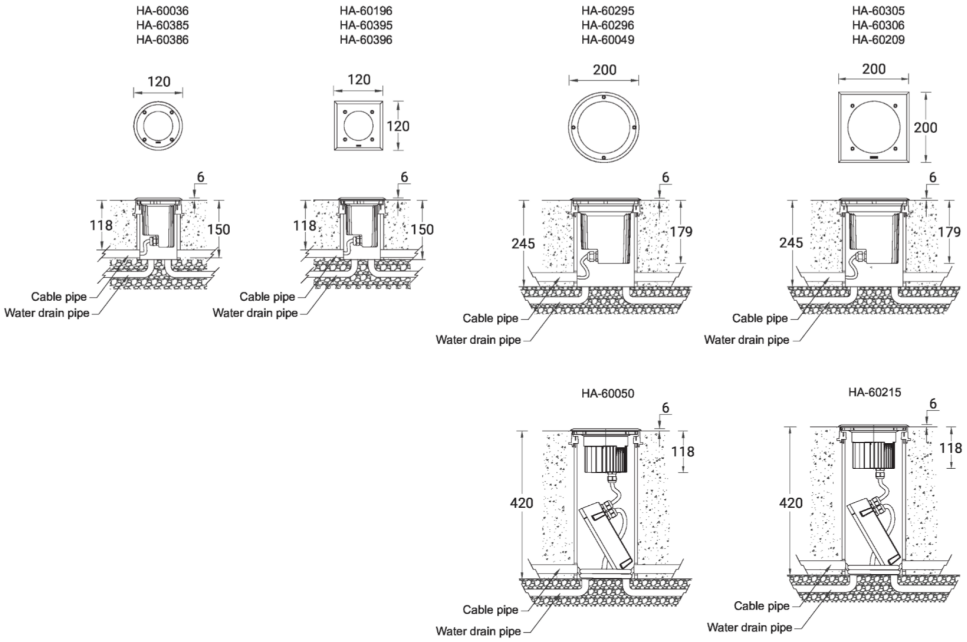
01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

HA-60306-S	·	·	·	·
HA-60385-A		·	·	·
HA-60385-S		·	·	·
HA-60386-A		·	·	·
HA-60386-S		·	·	·
HA-60395-A		·	·	·
HA-60395-S		·	·	·
HA-60396-A		·	·	·
HA-60396-S		·	·	·



We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

EQUIPMENT

MANUFACTURER	LIGMAN Lighting Co.,Ltd
CATALOG NUMBER	HA-60037-S-M-9530-ND-00
TOTAL WATTS	8
VOLTAGE	220-240
MOUNTING	In-grade
WEIGHT	0.7 kg
DIMENSIONS	120mm x 120mm x 150mm
FINISH	Stainless Steel
RATING	IP67
LISTING	IK10

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	95+
LUMEN OUTPUT	294
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Integral
PROVIDED BY	

ACCESSORIES

In-grade mount adjustable accent with one (1) LED lighting source, 294 delivered lumens, 3000K color engine, 95+ CRI, 22° optic and integral driver. Accent should operate on 220 -240 voltage and be supplied with a 0-10v control option and include a minimum 10-year warranty. Accent to have stainless steel finish. Accent to be rated for IP67 or equivalent. Accent should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

LIGMAN

HARRIER

Outdoor | **In-ground luminaires**

IP67 IK10

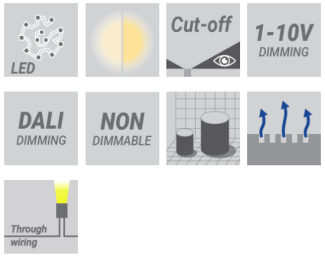
Complete, flexible, competitive accent and floodlight in-grounds. The lighting industry's leading quality low-cost in-ground fixture family.

microPrism™

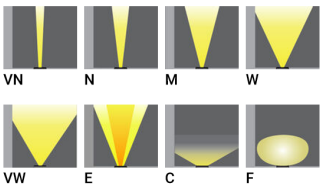
Luminaire Structure

- Die-cast aluminium housing
- Pre-treated before powder coating ensuring high corrosion resistance
- 6 mm thick front ring in grade 316 stainless steel or aluminium
- Single cable entry, through wiring upon request
- Stainless steel fasteners in grade 316
- Durable silicone rubber gasket
- High-efficiency PMMA lens
- Clear or frosted toughened glass
- Integral control gear for HA-60036, HA-60037, HA-60049, HA-60050, HA-60196, HA-60197, HA-60209, HA-60215, HA-60295, HA-60296, HA-60305, HA-60306
- Remote driver, remote box (IP-rated) and recessing box are included for HA-60385, HA-60386, HA-60395, HA-60396
- Recessing box in high-density polyethylene is included
- Suitable for walk-over with a maximum load of 200 kg

Feature

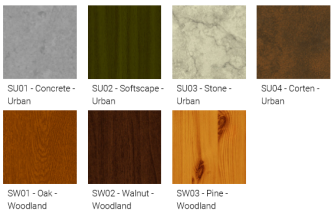


Optic



Product colour

Special finishes upon request



We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

Technical information

	Model number	Light source	Power	Lumen	Optic	CCT / CRI	Dimming type	Weight
Integral control gear - With recessing box - Round - Aluminium frame								
HARRIER 3	**HA-60050-A**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.4 kg
HARRIER 3	**HA-60295-A**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
Integral control gear - With recessing box - Round - Stainless steel frame								
HARRIER 3	**HA-60295-S**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
Integral control gear - With recessing box - Square - Aluminium frame								
HARRIER 4	**HA-60306-A**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
Integral control gear - With recessing box - Square - Stainless steel frame								
HARRIER 4	**HA-60306-S**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
Integral control gear - With recessing box - Round - Aluminium frame								
HARRIER 1	**HA-60036-A**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.5 kg
HARRIER 1	**HA-60037-A**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.5 kg
Integral control gear - With recessing box - Round - Stainless steel frame								
HARRIER 1	**HA-60036-S**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.7 kg
HARRIER 1	**HA-60037-S**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.7 kg
HARRIER 3	**HA-60050-S**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.6 kg
Integral control gear - With recessing box - Square - Aluminium frame								
HARRIER 2	**HA-60196-A**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.5 kg
HARRIER 2	**HA-60197-A**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.5 kg
HARRIER 4	**HA-60209-A**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
HARRIER 4	**HA-60215-A**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.4 kg
HARRIER 4	**HA-60305-A**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
Integral control gear - With recessing box - Square - Stainless steel frame								
HARRIER 2	**HA-60196-S**	12 LED	6 W	163 - 291 lm	C [90°], F [78°]	3000K CRI80, 4000K CRI80	On/Off	0.7 kg
HARRIER 2	**HA-60197-S**	MR16-GU10	8 W	260 - 402 lm	N [13°], M [22°], VW [58°], E [12°x50°]	3000K CRI95, 4000K CRI95	On/Off	0.7 kg
HARRIER 4	**HA-60209-S**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
HARRIER 4	**HA-60215-S**	18 LED	29 W	2387 - 2899 lm	N [15°], M [28°], W [41°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.6 kg
HARRIER 4	**HA-60305-S**	12 LED	6 W	308 - 410 lm	C [95°], F [84°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
With recessing box / driver - Round - Aluminium frame								
HARRIER 3	**HA-60049-A**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg

We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

HARRIER 3	**HA-60296-A**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.1 kg
With recessing box / driver - Round - Stainless steel frame								
HARRIER 3	**HA-60049-S**	9 LED	15 W	1183 - 1468 lm	N [15°], M [26°], W [40°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
HARRIER 3	**HA-60296-S**	7 LED	22 W	2234 - 2351 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	2.3 kg
With remote box IP-rated / remote driver / recessing box - Round - Aluminium frame								
HARRIER 1	**HA-60385-A**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
HARRIER 1	**HA-60386-A**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
With remote box IP-rated / remote driver / recessing box - Round - Stainless steel frame								
HARRIER 1	**HA-60385-S**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg
HARRIER 1	**HA-60386-S**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg
With remote box IP-rated / remote driver / recessing box - Square - Aluminium frame								
HARRIER 2	**HA-60395-A**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
HARRIER 2	**HA-60396-A**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.5 kg
With remote box IP-rated / remote driver / recessing box - Square - Stainless steel frame								
HARRIER 2	**HA-60395-S**	3 LED	8 W	531 - 733 lm	N [24°], M [28°], W [45°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg
HARRIER 2	**HA-60396-S**	1 LED	8 W	548 - 555 lm	VN [8°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	0.7 kg

Accessory

	Anti slip glass **A60212**	Connector IP68 5 Pin Power + Signal **A613191**	Connector IP68 3 Pin Power **A62591**	DALI Control System **Control-DALI**
HA-60036-A		·	·	
HA-60036-S		·	·	
HA-60037-A		·	·	
HA-60037-S		·	·	
HA-60049-A	·	·	·	·
HA-60049-S	·	·	·	·
HA-60050-A	·	·	·	·
HA-60050-S	·	·	·	·
HA-60196-A		·	·	
HA-60196-S		·	·	
HA-60197-A		·	·	
HA-60197-S		·	·	
HA-60209-A	·	·	·	·
HA-60209-S	·	·	·	·
HA-60215-A	·	·	·	·
HA-60215-S	·	·	·	·
HA-60295-A	·	·	·	·
HA-60295-S	·	·	·	·
HA-60296-A	·	·	·	·
HA-60296-S	·	·	·	·
HA-60305-A	·	·	·	·
HA-60305-S	·	·	·	·
HA-60306-A	·	·	·	·

We reserve the right to make technical and design changes.

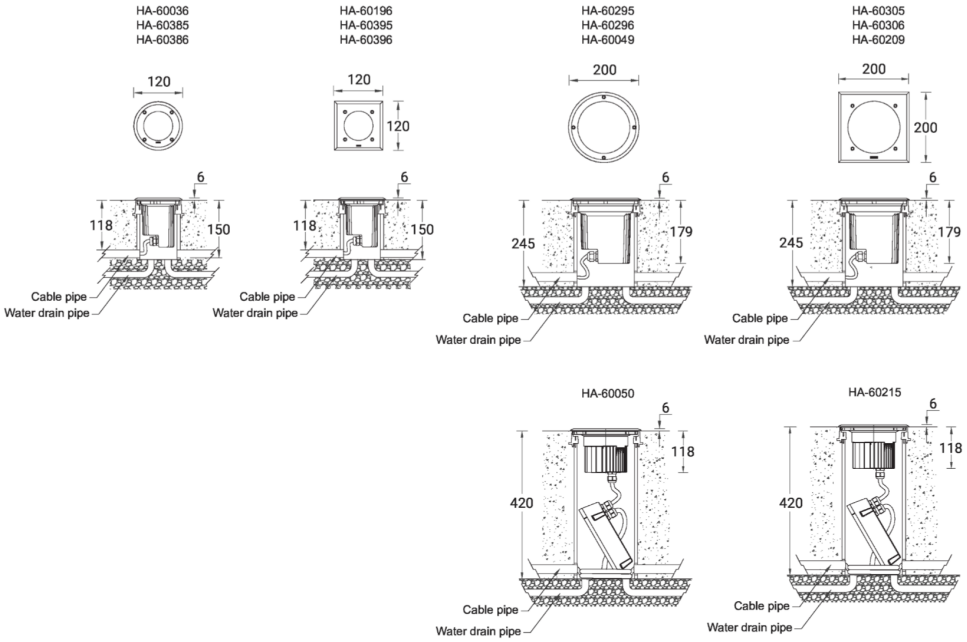
01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

HA-60306-S	·	·	·	·
HA-60385-A		·	·	·
HA-60385-S		·	·	·
HA-60386-A		·	·	·
HA-60386-S		·	·	·
HA-60395-A		·	·	·
HA-60395-S		·	·	·
HA-60396-A		·	·	·
HA-60396-S		·	·	·



We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/harrier-in-ground-luminaires-ha-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

EQUIPMENT

MANUFACTURER	LIGMAN Lighting Co.,Ltd
CATALOG NUMBER	LA-60004-AS-8030-DI-00
TOTAL WATTS	56
VOLTAGE	220-240
MOUNTING	In-grade
WEIGHT	7.8 kg
DIMENSIONS	1323mm x 85mm x 90mm
FINISH	Stainless Steel
RATING	IP67
LISTING	IK10

SOURCE

MANUFACTURER	LED Included
CATALOG NUMBER	LED Included
QUANTITY	1
CCT	3000K
CRI	80+
LUMEN OUTPUT	3573
ANTICIPATED LIFE	

POWER SUPPLY

TYPE	Remote
PROVIDED BY	

ACCESSORIES

In-grade mount linear wall wash with one (1) LED lighting source, 3573 delivered lumens, 3000K color engine, 80+ CRI, 27° x 60° optic and remote driver. Wall Wash should operate on 220-240 voltage and be supplied with a 0-10v control option and include a minimum 10-year warranty. Contractor to provide and install remote driver in location shown in plans or recommend alternate location, to be approved by designer or system integrator, while conforming to manufacturer's recommend installation documentation. Wall wash to have stainless steel finish. Wall Wash to be rated for IP67 or equivalent. Wall Wash should be UL listed or an approved equivalent.

CONTROL

PROTOCOL	0-10V
INTENT	Dimming

NOTES

Contractor to field verify mounting conditions and provide all hardware necessary to complete installation. Refer to the plans, equipment schedule and specifications for additional accessories and mounting requirements.

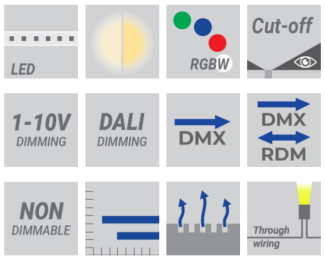
IP67 IK10

Efficient quality linear fixture portfolio.
Coordinated in-ground range with multiple optics and component options.

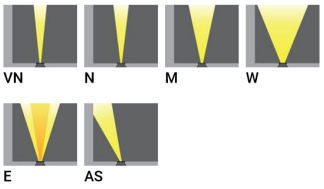
Luminaire Structure

- Die-cast aluminium end-caps
- Extruded aluminium housing
- Pre-treated before powder coating ensuring high corrosion resistance
- Stainless steel frame on request
- Single cable entry, through wiring upon request or two cable entries for through wiring
- Stainless steel fasteners in grade 316
- Durable silicone rubber gasket
- Clear toughened glass
- Integral control gear for LA-60001, LA-60002, LA-60003, LA-60004, LA-60013, LA-60014
- Remote driver is not included for constant voltage (CV) products
- Recessing box is included
- Suitable for walk-over with a maximum load of 500 kg
- 24 VDC input, DMX/RDM address with stable signal

Feature



Optic



Product colour

We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/lightalk-in-ground-luminaires-li-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

Technical information

	Model number	Light source	Power	Lumen	Optic	CCT / CRI	Dimming type	Weight	
With recessing box - Integral control gear - 1250 mm - Class I - RGBW									
LIGHTALK 2	**LA-60014**	40 LED	66 W	3302 - 3839 lm	VN [10°], N [13°], M [25°], W [43°], E [18° x35°]	RGBW30, RGBW40	DMX, DMX/RDM	7.4 kg	
With recessing box - Integral control gear - 1250 mm - Class I									
LIGHTALK 1	**LA-60002**	36 LED	56 W	3908 - 5703 lm	VN [12°], N [14°], M [24°], W [42°], E [18° x35°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	7.8 kg	
LIGHTALK 1	**LA-60004**	36 LED	56 W	3573 - 3760 lm	AS [27°x60°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	7.8 kg	
With recessing box - Integral control gear - 655 mm - Class I									
LIGHTALK 1	**LA-60001**	18 LED	28 W	1943 - 2847 lm	VN [12°], N [14°], M [24°], W [44°], E [18° x35°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	4.6 kg	
LIGHTALK 1	**LA-60003**	18 LED	28 W	2187 - 2566 lm	AS [27°x60°]	3000K CRI80, 4000K CRI80	On/Off, 1-10V, DALI	4.6 kg	
With recessing box - Integral control gear - 655 mm - Class I - RGBW									
LIGHTALK 2	**LA-60013**	20 LED	33 W	1592 - 1916 lm	VN [10°], N [13°], M [24°], W [43°], E [16° x35°]	RGBW30, RGBW40	DMX, DMX/RDM	4.9 kg	
Without remote driver - With recessing box - Constant voltage (CV) 24 V - 1250 mm - Class III									
LIGHTALK 11	**LA-60023**	36 LED	51 W	3871 - 4975 lm	VN [13°], N [15°], M [25°], W [42°], E [21° x 36°]	3000K CRI80, 4000K CRI80	On/Off	7.1 kg	
LIGHTALK 11	**LA-60026**	36 LED	51 W	4483 - 4719 lm	AS [27°x60°]	3000K CRI80, 4000K CRI80	On/Off	7.1 kg	
Without remote driver - With recessing box - Constant voltage (CV) 24 V - 1250 mm - Class III - RGBW									
LIGHTALK 12	**LA-60033**	36 LED	70 W	1810 - 4025 lm	N [16°], M [32°], W [55°], E [20°x30°]	RGBW30, RGBW40, RGB+Amber	DMX, DMX/RDM	7.8 kg	
Without remote driver - With recessing box - Constant voltage (CV) 24 V - 455 mm - Class III									
LIGHTALK 11	**LA-60021**	12 LED	16 W	1401 - 1823 lm	VN [13°], N [15°], M [26°], W [43°], E [20° x 35°]	3000K CRI80, 4000K CRI80	On/Off	2.4 kg	
LIGHTALK 11	**LA-60024**	12 LED	16 W	1458 - 1535 lm	AS [27°x60°]	3000K CRI80, 4000K CRI80	On/Off	2.4 kg	
Without remote driver - With recessing box - Constant voltage (CV) 24 V - 455 mm - Class III - RGBW									
LIGHTALK 12	**LA-60031**	12 LED	24 W	510 - 1383 lm	N [16°], M [32°], W [55°], E [20°x30°]	RGBW30, RGBW40, RGB+Amber	DMX, DMX/RDM	3.2 kg	
Without remote driver - With recessing box - Constant voltage (CV) 24 V - 655 mm - Class III									
LIGHTALK 11	**LA-60022**	18 LED	25 W	2202 - 2760 lm	VN [13°], N [15°], M [26°], W [44°], E [20° x 36°]	3000K CRI80, 4000K CRI80	On/Off	4.2 kg	
LIGHTALK 11	**LA-60025**	18 LED	25 W	2241 - 2360 lm	AS [27°x60°]	3000K CRI80, 4000K CRI80	On/Off	4.2 kg	

We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/lightalk-in-ground-luminaires-li-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

Without remote driver - With recessing box - Constant voltage (CV) 24 V - 655 mm - Class III - RGBW

LIGHTALK 12	**LA-60032**	18 LED	35 W	905 - 2012 lm	N [16°], M [32°], W [55°], E [20°x30°]	RGBW30, RGBW40, RGB+Amber	DMX, DMX/RDM	4.6 kg

Accessory

	Driver (CV) - On/Off - 36 W - IP67 - 24 V **A34491-ND**	Driver (CV) - On/Off - 60 W - IP67 - 24 V **A34591-ND**	Driver (CV) - On/Off - 100 W - IP67 - 24 V **A34791-ND**	Driver (CV) - On/Off - 150 W - IP67 - 24 V **A34891-ND**	Driver (CV) - On/Off - 200 W - IP67 - 24 V **A34991-ND**	Driver (CV) - On/Off - 350 W - IP67 - 24 V **A35091-ND**	Connector IP68 5 Pin Power + Signal **A613191**
LA-60001							·
LA-60002							·
LA-60003							·
LA-60004							·
LA-60013							
LA-60014							
LA-60021	·	·	·	·	·	·	
LA-60022	·	·	·	·	·	·	
LA-60023	·	·	·	·	·	·	
LA-60024	·	·	·	·	·	·	
LA-60025	·	·	·	·	·	·	
LA-60026	·	·	·	·	·	·	
LA-60031		·	·	·			
LA-60032		·	·	·			
LA-60033		·	·	·			

	Connector IP68 3 Pin Power **A62591**	Cable - Connector IP67 Female 2 Pin Power - 1000 mm **A65491-001**	Cable - Connector IP67 Female 2 Pin Power - 5000 mm **A65491-005**	Cable - Connector IP67 Female + Male 2 Pin Power - 1000 mm **A65591-001**	Cable - Connector IP67 Female + Male 2 Pin Power - 5000 mm **A65591-005**	Connector IP67 Female 2 Pin Power **A68191**	Connector IP67 Male 2 Pin Power **A68291**
LA-60001	·						
LA-60002	·						
LA-60003	·						
LA-60004	·						
LA-60013							
LA-60014							
LA-60021		·	·	·	·	·	·
LA-60022		·	·	·	·	·	·
LA-60023		·	·	·	·	·	·
LA-60024		·	·	·	·	·	·
LA-60025		·	·	·	·	·	·
LA-60026		·	·	·	·	·	·
LA-60031							
LA-60032							
LA-60033							

	DALI Control System **Control-DALI**	DMX Control System **Control-DMX**	DMX/RDM Control System **Control-DMX-RDM**
LA-60001	·		

We reserve the right to make technical and design changes.

01:30, 17-01-2026

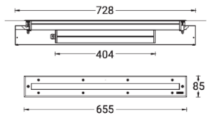
https://www.ligman.com/lightalk-in-ground-luminaires-li-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

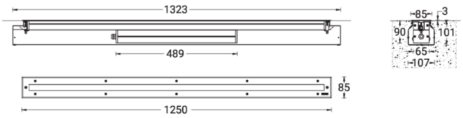
GLP Good Labour Practices

LA-60002	•			
LA-60003	•			
LA-60004	•			
LA-60013		•		•
LA-60014		•		•
LA-60021				
LA-60022				
LA-60023				
LA-60024				
LA-60025				
LA-60026				
LA-60031		•		•
LA-60032		•		•
LA-60033		•		•

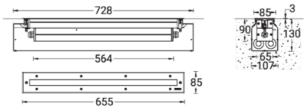
LA-60001, LA-60003



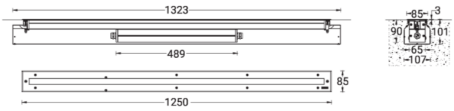
LA-60002, LA-60004



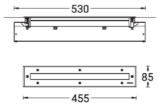
LA-60013



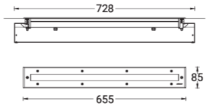
LA-60014



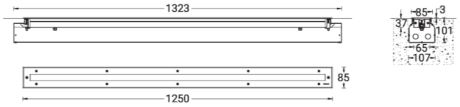
LA-60021, LA60024



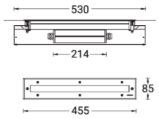
LA-60022, LA-60025



LA-60023, LA-60026

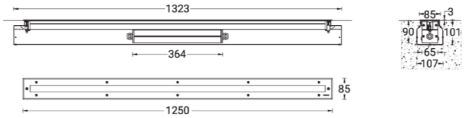


LA-60031



LA-60032

LA-60033



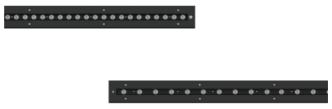
We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/lightalk-in-ground-luminaires-li-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices



LIGHTALK
Recessed luminaires

Efficient quality linear fixture portfolio.
Coordinated wall or ceiling recessed range with multiple optics and component options.

https://www.ligman.com/lightalk-recessed-luminaires-li-re3/

LIGHTALK
Pendant luminaires

Efficient quality linear fixture portfolio.
Coordinated pendant range with multiple optics and component options.

https://www.ligman.com/lightalk-pendant-luminaires-li-pe3/

LIGHTALK
Wall washer floodlights

Efficient quality linear fixture portfolio.
Coordinated grazing-floodlight range with multiple optics and component options.

https://www.ligman.com/lightalk-wall-washer-floodlights-li-pr3/

We reserve the right to make technical and design changes.

01:30, 17-01-2026

https://www.ligman.com/lightalk-in-ground-luminaires-li-in3/

THAILAND
LIGMAN Lighting Co.,Ltd.
17/2 Moo 4, Monthong, Bang Nam Priao,
24150 Chachoengsao - Thailand
info@ligman.com

GLP Good Labour Practices

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:

1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
2. Sleeves and seals for electrical penetrations.
3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
4. Sealing penetrations through noise critical spaces.

1.02 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these Specifications:

1. AHJ: Authority(ies) having Jurisdiction
2. ATS: Acceptance Testing Specifications
3. EMT: Electrical Metallic Tubing
4. EPDM: Ethylene-propylene-diene terpolymer rubber
5. MC: Metal Clad
6. N/A: Not Available or Not Applicable
7. NBR: Acrylonitrile-butadiene rubber
8. NRTL: Nationally Recognized Testing Laboratory
9. PCF: Pounds per Cubic Foot
10. STC: Sound Transmission Class

B. The following definitions apply to this and other Sections of these Specifications:

1. HOMERUN: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":

1. Product data for the following products:
   a) Sleeve seals
   b) Through and membrane penetration firestopping systems
   c) Joint Sealers
   d) Acoustical sealers
2. Shop drawings for:
   a) Detailed fabrication drawings of access panels and doors
3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
   a) Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
   b) Qualifications Data for testing agency.

4. Endothermic Wrap drawings and system details: Provide UL listing, assembly rating and installation drawing for each case specific installation. Include installation instructions indicating layers of wrap required and securing method.

5.

6. Record Drawings: Submit Record Drawings as required by Division 1 and Division 26

   a) Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structureal elements.

1.05 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.

		STC Level
1.	Offices	25
2.	Sound/Lighting Control Rooms	25
3.	Stage	25
4.	A/V Spaces	25

PART 2 - PRODUCTS

2.01 ACCESS TO EQUIPMENT

A. Available Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section “Identification for Electrical Systems” for labeling of access doors.

2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

3. Access doors must be of the proper construction for type of construction where installed.

4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

    a) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.

    b) For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.

    c) For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

    a) Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices:

    a) Flush, screwdriver-operated cam locks.

    b) Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys per access panel.

2.02 SLEEVES

A. Steel Sleeves for Raceways and Cables:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables:

1. Available Manufacturers:

a) Josam Mfg. Co.

b) Smith (Jay R) Mfg. Co.

c) Tyler Pipe/Wade Div.; Subs of Tyler Corp.

d) Watts Industries, Inc.

e) Zurn Industries, Inc.; Hydromechanics Div.

2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.

a) Underdeck Clamp: Clamping ring with setscrews.

3. Sleeves for rectangular Openings: Galvanized sheet steel with minimum 0.52- inch or 0.138- inch thickness as indicated and of length to suit application.

4. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section “Through-Penetration Firestop Systems.”

2.03 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2. Available Manufacturers:

a) Advance Products & Systems, Inc.

b) Calpico, Inc.

c) Metraflex Co.

d) O-Z/Gedney

e) Pipeline Seal and Insulator, Inc.

3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.

a) EPDM

b) NBR

c) Neoprene

4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.

a) Plastic

b) Carbon Steel

c) Stainless Steel

d) PVC-coated Steel

5. Connecting Bolts and Nuts: Provide bolts of length required to secure pressure plates to sealing elements.

a) Carbon Steel with Corrosion-Resistant Coating

b) Stainless Steel

B. JOINT SEALERS

1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.

3. Elastomeric Joint Sealers: Provide the following types:

a) Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

1) Dow Corning, Dowsil 790

2) Dow Corning, Dowsil 795

3) GE, Silglaze II SCS

4) GE, Silpruf SCS 2000

5) Owens Corning, Energy Complete

6) Pecora, 864 NST

7) Tremco, Spectrem 1

8) Tremco, Spectrem 2

b) Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

1) Dow Corning, Dowsil 786

2) GE, Momentum SCS 1700

3) Pecora, 898 Silicone NST

c) Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:

1) BASF, MasterSeal NP 100

2) Pecora, DyanTrol I-XL

3) Tremco, Dymonic FC

C. FIRESTOPPING

1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:

a) Available Manufacturers:

1) 3M Corp., Fire Barrier Sealant

2) Hilti, Inc.

3) Tremco, Tremstop Fyre-Sil

4) Pecora, AC-20 FTR

5) RectorSeal

6) Specified Technologies Inc. Firestop

7) USG, SHEETROCK Firecode Compound

8) Owens Corning Firestopping Insulation

D. ACOUSTICAL SEALANTS

1. General: Penetrations by conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

2. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.

3. Non-Hardening Penetration Sealant: Sealant for penetrations shall be non-hardening, permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated

4. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).

5. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. Meeting ASTM E 84 for a smoke flame spread index of less than 25 / 50. Subject to compliance with requirements, provide one of the following:

   a) Pecora, AC-20 FTR

   b) Pecora, AIS-919

   c) USG, SHEETROCK Acoustical sealant

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

D. Comply with NECA 1.

E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.

F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

H. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 ACCESS DOORS

A. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.

B. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.

C. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

3.03 SLEEVES AND SLEEVE SEALS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Provide all sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical Work that passes through such construction. Coordinate with all other trades and Divisions to dimension and lay out all such openings.

C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other Divisions.

D. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.

E. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.

F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

G. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

H. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.

I. Sleeve Length:

1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.

2. Sleeves through floors: Extend sleeves 2 inches above finished floor level.

J. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed; in which case, size sleeves as recommended by the seal manufacturer.

K. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

L. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

M. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

N. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

O. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

P. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

   a) Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

   b) Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.

   c) Install galvanized sheet metal for rectangular sleeves

   d) Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

Q. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

R. Concrete Slab on Grade Penetrations:

1. Provide ½" thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.

S. Elevated Floor Penetrations of waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum ½" annular space between wall pipe and cable or raceway.

2. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

3. Secure waterproof membrane flashing between clamping flange and clamping ring.

4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

T. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.

U. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

V. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

W. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

X. Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.

2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Y. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

Z. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.04 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.05 JOINT SEALERS

A. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.

2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

B. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

a) Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

b) Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

2. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways

penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.06 ACOUSTICAL PENETRATIONS

A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.

B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes limited scope for electrical connections to equipment specified under other Sections or Divisions, or furnished under separate contracts or by the Owner.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

B. Coordinate with work described in Division 11 Sections for equipment requiring electrical connection.

C. Coordinate with work described in Division 23 Section “Common Work Results for HVAC”.

D. Coordinate with work described in Division 23 Section “Direct-Digital Control for HVAC”.

E. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

F. Determine connection locations and rough-in requirements based on Shop Drawings.

G. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

H. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products for:
    a) Special connectors
    b) Special conductors or cable assemblies
2. Shop drawings for:

a) Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.

2. Marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CORDS AND CAPS

A. Attachment Plugs: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.

C. Cord: See Paragraph “Flexible Cords” in Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.02 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.03 ELECTRICAL DEVICES

A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated, specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.04 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturers' instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.05 EQUIPMENT

A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.

C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

3.06 SMOKE EVACUATION

A. Life Safety feeders shall be installed in fire rated enclosures or shall be constructed as a rated assembly per NEC 700 and IBC 403.

B. Life Safety feeders shall not be routed in the same enclosures as other feeder types except as permitted by NEC 700.

C. Life Safety loads shall be as defined by NEC 700 and IBC 403 including but not limited to the following:

1. Egress Lighting
2. Smoke Evacuation Fans
3. Stair Pressurization Fans
4. Atrium Ventilation Fans

3.07 FOOD SERVICE (SERVERY) EQUIPMENT

A. Provide power connection to all equipment as indicated or as otherwise required to accommodate the equipment indicated in the food service equipment drawings and specifications.

B. Coordinate and provide the appropriate receptacle for equipment being installed as required for proper operation. Coordinate the required quantity of conductors prior to pulling wire to outlet box.

C. Provide a local recessed non-fused equipment disconnect for kitchen equipment as required by the applicable codes and jurisdictions. Coordinate exact location prior to rough-in and maintain all code required clearances.

D. Provide control wiring and conduit for all equipment that is not indicated as being within the responsibility of the equipment manufacturer or installer.

E. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, shall be provided by the equipment installer, unless otherwise noted.

F. Coolers and Freezers: Cut conduit openings in freezer and cooler walls, floor, and ceilings, in accordance with manufacturers' instructions, when openings are not provided by the manufacturers. Seal around conduit penetrations air tight with an approved pliable material suitable for low temperatures. Effectively seal interiors of conduits, by installing a conduit fitting at the boundary of the two spaces, and filling it with an approved pliable material, after conductors or cables have been installed and tested.

G. Provide all grounding systems as required by the equipment supplier.

3.08 DOOR OPERATORS AND HARDWARE

A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.

C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.

D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

3.09 SIGNAGE AND WAYFINDING

A. Provide junction boxes and disconnect switches per manufacturer's installation drawings.

B. Coordinate rough-in requirements with signage.

C. Coordinate box locations and conduit routing with parapets and roof elevations.

D. Provide labelling on all junction boxes and disconnects in accordance with Division 26 section “Identification for Electrical Systems”

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provisions for Underground Secondary Electrical Service.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Utility service voltage:

1. 480Y/277 volts, three-phase, four-wire, 60Hz

B. Utility service ampacity: As indicated on the Drawings.

C. The extent of Work for the secondary electrical service includes providing the following:

1. Raceways
2. Provisions for Metering
3. Grounding and Bonding
4. Concrete pad for service transformer
5. Service lateral

1.03 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

B. Product data for the following products for:

1. Meter bases
2. Current transformer cabinets

C. Shop drawings for:

1. Utility Company prepared installation drawings
2. Cast-in-place concrete pads

D. Field quality-control test reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
4. Utility voltage adjustment request.

E. Where equipment or materials are specified to comply with utility standards and are listed above as required submittals, obtain approval from the serving utility before submitting to the Contract Administrator.

F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual routing of interior conduits two-inch and larger trade size and all exterior buried raceway, including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that Indicate dimensions from finished grade or other fixed structural elements.

1.04 QUALITY ASSURANCE

A. Perform all work in accordance with Utility Company installation drawings and service standards.

B. Maintain one copy of Utility Company installation drawings and service standards at the site.

C. Prior to commencing work in this Section, meet with the Utility Company representative to review service entrance requirements and details.

D. Verify that field measurements are as indicated on Utility Company drawings.

E. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.

2. Marked for intended use.

F. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 (NOT USED)

PART 3 - EXECUTION

3.01 SECONDARY SERVICE ENTRANCE UNDERGROUND

A. Provide an underground secondary service lateral from the pad mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service lateral conductor and raceway quantities, sizes, and types.

B. The Utility Company will provide the service transformer.

C. Provide a concrete pad, complying with the Utility Company standards, for transformer mounting, and set coated GRS conduit elbows and riser(s), with grounding bushing(s), to receive primary and secondary raceways. Where direct burial primary is used, set coated GRS conduit elbow(s) and riser(s), with grounding bushing(s), to receive primary cables.

D. Make connections to the secondary terminals of the transformer as required and in conformance with Utility Company requirements. Utility Company will provide primary conductors and terminal connections unless otherwise directed by the Utility Company.

3.02 METERING

A. Provide a 2-inch empty PVC Schedule 80 conduit, with pull cord, from the secondary compartment of the pad-mounted service transformer to the meter locations shown in the drawings, or as directed by the Utility Company. Provide a #6 AWG bare copper wire parallel to conduit with 6' of coiled length at each end.

B. Install the meter base furnished by the Utility Company.

C. Install the current transformer cabinet furnished by the Utility Company.

D. The Utility Company will provide the meter and meter wiring.

3.03 UTILITY SERVICE CHARGES

A. It shall be the responsibility of the Division 26 contractor to apply for the electrical service, including the preparation and completion of all forms. Submit the completed application along with all other required documentation for the new or modified service.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conductors, cables, and cords rated 600V and less.

B. Connectors and terminations rated 600V and less.

1.02 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these specifications:

1. MC: Metal Clad
2. NBR: Acrylonitrile-butadiene rubber
3. NETA ATS: Acceptance Testing Specification.

B. The following definitions apply to this and other Sections of these Specifications:

1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.

a) Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
2. Coordinate routing of feeders and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for feeders and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:

a) Feeders for Emergency Power systems where in areas not protected by an automatic fire suppression system.

b) Smoke Removal systems

3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

4. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:

a) Conductors, cables, and cords rated 600V and less.

b) Metal Clad (MC) cable and fittings.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Field quality-control test reports in accordance with NETA ATS:

1. Submit all system and component test results.

1.05 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.

C. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by

manufacturer's instructions. When installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES - GENERAL

A. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.

1. Solid conductor for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger.
2. Stranded for all flexible cords, cables, and control wiring.
3. As noted otherwise below.

B. Conductor Insulation Types: Type THHN/THWN-2 or XHHW-2 complying with ICEA S-95-658/NEMA WC70.

C. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).

D. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre manufactured whips for light fixtures which may be No. 14 AWG.

E. Unless otherwise indicated, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.

F. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.02 SINGLE CONDUCTORS

A. Manufacturers:

1. Alan Wire
2. Cerrowire
3. Colonial Wire & Cable Co., Inc.
4. Encore Wire Corporation
5. General Cable (Prysmian Group)

6. Northern Cables Inc.
7. Okonite Company
8. Priority Wire and Cable
9. Southwire Company

B. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

PHASE	120/240V	240D/120V	208Y/120V	480Y/277V
A	Black	Black	Black	Brown
B	Red	Orange	Red	Orange
C	N/A	Red	Blue	Yellow
Neutral	White	White	White	Gray**
Equipment Ground	Green	Green	Green	Green
Isolated Ground	N/A	N/A	Green/Yellow Stripe	Green/Yellow Stripe

**Except as provided in NFPA 70.

2.03 METAL CLAD CABLE, TYPE MC

A. General:

1. Shall not be used for life safety or critical systems.

B. MC Cable (with insulated green grounding conductor, no bonding conductor):

1. Manufacturers:
   a) Atkore/AFC Cable Systems
   b) Cerrowire
   c) Encore Wire Corporation (MC)
   d) Kaf-Tech
   e) Northern Cables, Inc.
   f) Southwire Company (Amorlite)
2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor (aluminum color).
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color-coded as listed for single conductors with solid colors using ICEA Method 1.

5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.

6. Marking: Cable markings shall comply with the requirements of NFPA 70.

C. MC Cable (with 0-10V dimming control wiring):

1. Manufacturers:

a) Atkore/AFC Cable Systems

b) Cerrowire

c) Encore Wire Corporation (MC- LED)

d) Southwire Company (MC – PCS Duo)

2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.

3. Armor Assembly: Aluminum interlocked armor (aluminum color).

4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.

5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.

6. Control Conductors: Color-coded Class 2/Class 3 twisted jacketed pairs

7. Marking: Cable markings shall comply with the requirements of NFPA 70.

D. MC Cable Fittings:

1. Manufacturers:

a) ABB/T&B

b) Arlington

c) Eaton/Crouse-Hinds

d) Emerson/O-Z Gedney

2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.

3. Fittings shall be insulated type not requiring the use of anti-short bushings.

4. Romex style, clamp type fittings are not acceptable.

2.04 FLEXIBLE CORDS

A. Manufacturers:

1. Cerrowire
2. Priority Wire and Cable
3. Southwire

B. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, extra-hard-usage; Type SEO, SO, or STO for indoor dry and damp locations; SEOW, SOW, or STOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

C. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, hard-usage; Type SJEO, SJO, or SJTO for indoor dry locations; SJEOW, SJOW, or SJTOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

2.05 CONTROL WIRING

A. Refer to Division 23 Section “Direct-Digital Control for HVAC”

B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.06 CONNECTORS

A. Available Manufacturers:
1. AMP; Tyco
2. FCI-Burndy
3. Gould
4. Ideal Industries, Inc.
5. Ilsco
6. NSi Industries, Inc.
7. O-Z/Gedney
8. NSI Industries, Inc. (Polaris)
9. Panduit
10. Thomas and Betts
11. 3-M Electrical Products Division

B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug”, or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
1. Termination fittings for copper conductors: Bare copper 1-hole pad and inspection port.

2. Termination fittings for aluminum conductors: Tinned aluminum 1-hole pad.

C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings: Bare copper, 1-hole pad and inspection port; or,

2. Termination fittings: Tinned Aluminum, 1-hole pad.

D. Connectors for solid conductors No. 10 AWG and smaller: twist-on insulated spring connectors (wirenuts). Color-coded for size, except use green only for grounding connections.

E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: ring-tongue type.

F. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.

G. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

H. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3- EXECUTION

3.01 PREPARATION

A. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

B. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.

C. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on

the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

3.02 INSTALLATION

A. General:

1. Unless otherwise indicated on the Drawings on in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.
2. Install in accordance with manufacturer’s instructions.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
6. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.
7. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
8. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.
9. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
10. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
11. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply (unless shown or noted otherwise on drawings,) which are in addition to those in NFPA 70:
    a) Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.

1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.

2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

b) Normal or Non-Essential circuits.

1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.

2) The minimum wire size for all conductors in this raceway: No. 10 AWG.

3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

c) GFCI-protected circuits.

1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.

d) Isolated Ground (IG) Circuits:

1) Do not use multi-conductor or MC cables.

2) Do not share neutrals between separate circuits.

3) Do not share the isolated grounding conductor with more than one device (i.e., each device on an IG circuit shall have its own dedicated IG conductor back to the branch panelboard IG bus).

4) The equipment grounding conductor may be shared between IG circuits sharing a common raceway.

12. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.

13. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.

14. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:

a) Wet or dry locations, in raceways:

1) Service entrance: Type THHN/THWN-2, THWN, or XHHW-2.

2) Feeders and branch circuits: Type THHN/THWN-2, THWN, or XHHW-2.

3) Conductors 6 AWG and smaller: Types THHN/THWN-2 or THWN.

4) Conductors used between a variable frequency drive (VFD) and associated motor: Type XHHW-2.

B. Aluminum Conductor Option:

1. Terminations: Tinned, mechanical type only; UL-listed for copper and aluminum conductors at 75 degrees C minimum.

2. Increase the raceway size as required, at no additional cost to the Owner, to accommodate the increased size of the aluminum conductors.

3. Aluminum conductor size shall meet or exceed the ampere rating of the scheduled copper conductors at 75 degrees C.

4. Option applies only for the following feeders or services; minimum size as indicated in "Conductors and Cables" materials section above:

a) Service entrance conductors

b) Service and feeder conductors under 200A shall be copper.

c) Normal power service and feeder wiring 200A and over shall be aluminum unless otherwise prohibited. Copper may be used at no additional cost.

1) Exceptions:

(a) All feeders connecting directly to motors including, but not limited to chillers and fire pumps shall be copper to minimize loosening of connectors due to cyclical thermal expansion.

(b) Branch circuits shall be copper.

(c) All essential power systems shall be copper.

d) Feeders to switchboards

e) Feeders to panelboards

f) Feeders to motor control centers

g) Feeders to transformers

5. Measure the temperature of all aluminum conductors at all splices and terminations. Make each test under typical building load conditions after the building is occupied and in operation for a minimum of two weeks. Replace all joints or splices indicating excessive heating.

6. Take measurements with a non-contact type infrared thermometer, with target size not exceeding one inch at five feet and an accuracy of two

percent or better. Submit the meter specifications and calibration date with the test results.

C. Metal Clad Type MC Cable:

1. Securing and Supporting:

a) Support per NFPA 70 for MC cable

b) Secure cable within 12 inches of every box or fitting.

c) Secure/supporting intervals shall not exceed six (6) feet for MC cable.

d) Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.

2. Type MC cable may only be used:

a) In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.

b) For vertical drops in stud walls.

c) In lieu of metal raceway, only for 15A and 20A branch circuits with up to four (4) conductors, not including grounding and/or bonding conductor(s), and only in dry concealed locations above grade, except where specifically not permitted by NFPA 70.

3. MC cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:

a) Unjacketed MC:

1) In locations not permitted by NFPA 70.

2) When specifically not allowed by the local AHJ.

3) Where exposed to view.

4) Where subject to physical damage.

5) Corrosive or Hazardous locations.

6) Wet locations.

7) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.

8) Within mechanical, electrical or telecommunication equipment rooms.

9) Emergency circuits covered by NFPA 70.

b) PVC Jacketed MC

1) In locations not permitted by NFPA 70.

2) When specifically not allowed by the local AHJ.

3) Homeruns to panelboards.

4) Where exposed to view.

5) Where subject to physical damage.

6) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.

7) Within mechanical, electrical or telecommunication equipment rooms.

8) Emergency circuits covered by NFPA 70.

D. Flexible Cords

1. Refer to Division 26 Section, ""Equipment Wiring Systems", for electrical connections to equipment.

E. Control Wiring

1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.

2. Open wiring in air handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.

a) Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

F. Connections:

1. Apply a zinc based, anti-oxidizing compound to connections.

2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.

6. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.

   a) Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus

   b) Compression – splices, terminals

   c) Mechanical – where temporary removal is required

7. Do not use terminals on wiring devices to feed through to the next device.

3.03 IDENTIFICATION

A. General: Provide all identification per Division 26 “Identification for Electrical Systems”.

B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:

1. Factory provided colored insulation

2. Color-Coding Conductor Tape.

3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in pull boxes and junction boxes identify voltage source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

F. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section “Identification for Electrical Systems”. Note conductor identification on record Drawings.

3.04 FIELD QUALITY CONTROL

A. Do not perform insulation resistance tests of the distribution wiring to equipment with the surge protective devices installed. Disconnect surge protective device before conducting insulation resistance tests and reconnect immediately after the testing is over

B. Perform the following field tests and inspections and prepare test reports:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. This Section includes:

1. Grounding Electrodes
2. Ground Bars
3. Grounding Conductors
4. Connector Products

1.02 DEFINITIONS

A. The following apply to this and other Sections of these Specifications:

1. Ground ring: Bare underground grounding conductor encircling the building or structure.
2. NETA ATS: Acceptance Testing Specification.
3. PSF: Pounds per Square Foot
4. EMT: Electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. FMC: Flexible metal conduit.
7. GRS: Galvanized Rigid Steel Conduit
8. IMC: Intermediate metal conduit.
9. LFMC: Liquidtight flexible metal conduit.
10. LFNC: Liquidtight flexible nonmetallic conduit.
11. RAC: Rigid Aluminum Conduit
12. RMC: Rigid Metal Conduit
13. RNC: Rigid nonmetallic conduit.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:

a) Electrodes, mechanical and compression connectors, and exothermic connectors.

B. Qualification Data: For a qualified testing and inspecting agency engaged by Contractor.

C. Quality-Control Test Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record actual locations of all buried electrodes, bonding conductors and ground rings. Indicate dimensions from fixed structural elements.

1.04 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS (current version), "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
2. Marked for intended use.
3. Comply with UL 467.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

A. Manufacturers:

1. ABB, Inc.
2. Advanced Lightning Technology (ALT)
3. AFL Global
4. Boggs, Inc.

5. Burndy; Hubbell, Inc.
6. Cooper Power; Eaton.
7. Copperweld Corp.
8. ECN/Korns; Division of Robroy Industries.
9. Encore Wire Corporation.
10. Erico; nVent.
11. Galvan Industries, Inc.
12. Greaves Corp.
13. Harger.
14. Hastings Fiber Glass Products, Inc.
15. Heary Brothers Lightning Protection Co.
16. Ideal Industries, Inc.
17. ILSCO.
18. Lightning Master Corp.
19. Lyncole XIT Grounding; Division of VFC.
20. NSI Industries, Inc. (Polaris).
21. O-Z/Gedney Co.; Emerson.
22. Panduit, Inc
23. RACO; Hubbell, Inc.
24. Robbins Lightning, Inc.
25. Southwire.
26. Superior Grounding Systems, Inc.

2.02 GROUNDING ELECTRODES

A. Ground Rods: UL-listed

1. Copper-clad steel; bonded copper electrolytic ally-applied to minimum thickness of 10 mils.
2. Size: 5/8 inch by 8 feet. Provide sectional types when longer rods are indicated.

2.03 GROUND BARS

A. General

1. Ground bars described in this section are intended to be wall mounted bars used for grounding and bonding. Equipment ground buses for

switchboards, panelboards and miscellaneous equipment are described in the individual equipment sections.

2. Supports: Minimum of two each 1-1/2-inch insulators and 1-inch stainless steel offset mounting brackets.

2.04 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables"

B. Material:

1. Copper.

C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.

D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.

E. Underground Conductors:

1. Tinned-copper conductor.

2. No. 2/0 AWG minimum

3. Stranded, unless otherwise indicated.

F. Bare Copper Conductors:

1. Solid Conductors: Comply with ASTM B 3

2. Concentric-Lay Stranded Conductors: ASTM B 8.

3. Tinned Conductors: Comply with ASTM B 33.

G. Copper Bonding Conductors:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.

2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.

2.05 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors.

C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

1. Company symbol and/or logo.
2. Catalog number.
3. Conductors accommodated.
4. Installation die index number or die catalog number is required.
5. Underwriters Laboratories “Listing Mark:”.
6. The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL Standard ANSI/UL467 (latest revision).

D. Cast connectors: copper base alloy according to ASTM B 30 (latest revision).

E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.06 MISCELLANEOUS

A. Test Wells:

1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating; minimum 24 inches deep.
2. Non-traffic Areas: High density polyethylene; 350 PSF minimum load rating; minimum 10.25 inches deep.
3. Cover: Factory-identified by permanent means with word "GROUND".

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. GENERAL

1. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.

2. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.

3. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Application

1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

2. Underground Grounding Conductors: Unless noted otherwise, bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

C. Grounding Electrode System: Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

1. Provide continuous grounding electrode conductors without splice or joint.

2. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

3. Ground Rod Electrodes:

a) Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

b) Unless otherwise indicated, install ground rod electrodes vertically.

1) Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

2) Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

c) Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70. If depth is unachievable, notify Contract Administrator and Engineer.

d) Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

e) Verify that final backfill and compaction has been completed before driving rod electrodes.

f) Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.

4. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare, tinned copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor above footer and foundation and connect to building structural steel or other grounding electrode external to concrete.

5. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

6. Metal In-Ground Support Structures: Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

D. Equipment Grounding Conductors:

1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

2. Install equipment grounding conductors in all feeders and branch circuits.

3. In branch circuit and feeder raceways, use insulated equipment grounding conductors.

4. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

5. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components. On water heaters, bond metal hot and cold water pipes together, across the heater tank.

6. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

E. Ground Bars:

1. Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

a) Use insulated spacers and mounting brackets, and support from wall 2 feet above finished floor, unless otherwise indicated.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.

H. Bonding: Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:

1. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

2. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

4. Bond metallic elements likely to become energized or where indicated on the Drawings, including but not limited to fences around electrical equipment and metal drain bodies near pools or electrical equipment.

5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

6. Pole Mounted Luminaires: Bond metal enclosures and components of pole mounted luminaires to the grounding system per the Manufacturer's requirements.

3.03 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:

1. Connecting conductors together.

2. Connecting conductors to ground rods, except at test wells.

3. Connecting conductors to building steel.

4. Connecting conductors to plates.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:

a) Connecting conductors together.

b) Connecting conductors to building steel.

c) Connecting conductors to ground rods, except at test wells.

D. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:

a) Connecting conductors to ground rods at test wells.

b) Connecting conductors to pipes.

E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 GROUND RING

A. Ground the steel framework of the building with a buried electrode at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Protect taps for steel framing connections from physical damage at foundations and transitions to steel columns.

3.05 IDENTIFICATION

A. Provide identification as specified in Division 26 “Low-Voltage Electrical Power Conductors and Cables” and “Identification for Electrical Systems”.

3.06 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

4. Inspect and test in accordance with NETA ATS except Section 4.

5. Perform inspections and tests listed in NETA ATS, Section 7.13.

6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

7. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

8. Test Values:

   a) The resistance between the main grounding electrode and earth ground shall be no greater than 5 ohms.

   b) Equipment Rated 500 kVA and Less: 10 ohms.

   c) Equipment Rated 500 to 1000 kVA: 5 ohms.

   d) Equipment Rated More Than 1000 kVA: 3 ohms.

9. Minimum system neutral-to-ground insulation resistance: one megohm.

10. Investigate point-to-point resistance values that exceed 0.5 ohms.

    a) Check for loose connections.

    b) Check for absent or broken connections.

    c) Check for poor quality welds.

    d) Consider other reasons.

11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements

12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

13. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.02 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
7. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.

2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

C. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Submit fabrication drawings and product literature.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

A. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

a) Include strength derating requirements related to ambient temperature.

4. Equipment supports.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70 and applicable building code.

B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. General:

1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Use corrosion resistant materials suitable for the environment where installed.

1. Manufacturers:

a) Allied Tube & Conduit; Atkore International.

b) Eaton

c) Erico; nVent.

d) GS Metals Corp.

e) PHD Manufacturing.

f) Thomas & Betts Corporation.

g) Unistrut; Atkore International.

h) Wesanco, Inc.

2. Metallic Coatings:

a) Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

b) Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and Malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Conduit Straps: One-hole or two-hole type.

2. Conduit Clamps: Bolted type unless otherwise indicated.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a) Available Manufacturers:

1) Hilti Inc.

2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3) MKT Fastening, LLC.

4) Powers Fasteners, Inc;

5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a) Available Manufacturers:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

H. Wire Rope Hanging Systems:

1. Manufacturers:

   a) Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.

4. Wire Rope: Zinc coated, stainless steel or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

5. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

2.02 FABRICATED METAL CONDUIT OR EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

C. Rooftop support assemblies: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane.

1. Conduit supports: Unless noted otherwise, surface mounted fittings not requiring any attachment to the roof structure and not penetrating the roofing assembly with support fixtures.

2. Equipment supports: Attachment fittings for connection to roof structure.

D. Base Sizes: As required to prevent overturning and to distribute load sufficiently to prevent indentation of roofing assembly.

E. Mounting Height: Provide minimum clearance of 6 inches under supported components to top of roofing.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not provide support from roof deck.

C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.

D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:

1. Minimum rod size shall be 1/4 inch (6 mm) in diameter, unless otherwise indicated.

a) Equipment Supports: 1/2 inch diameter minimum.

b) Busway Supports: 1/2 inch diameter minimum.

c) Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter minimum.

d) Trapeze Support for Multiple Conduits: 3/8 inch diameter minimum.

2. Space supports for EMT, IMC, and RMC as required by NFPA 70.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:

a) two-bolt conduit clamps

b) single-bolt conduit clamps using spring friction action for retention in support channel

G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

H. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Supported load shall not exceed manufacturer's recommended load rating.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Install in accordance with manufacturer's instructions.

E. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

1. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

F. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

G. Do not use products for applications other than as permitted by NFPA 70 and product listing.

H. Remove temporary supports when no longer required.

I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

J. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

a) Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

5. To Steel:

a) Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts

b) Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69

c) Spring-tension clamps.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

K. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:

1. Accessible to untrained personnel.

2. Located within confined spaces.

E. Rooftop support assemblies:

1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.

2. Equipment supports: Coordinate installation of supports with roofing material installation.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Concrete"."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.02 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit
10. RTRC: Reinforced Thermosetting Resin Conduit

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".

B. Product data for the following products:

1. Floor boxes
2. Poke-Through Outlets

C. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

1.05 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
2. Marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

A. Metal Conduit and Tubing

1. Manufacturers:
   a) ABB, Inc.
   b) Atkore
   c) American Conduit
   d) Anamet Electrical, Inc.
   e) Electri-Flex Co.
   f) Hubbell (Fittings).

g) Nucor Tubular Products.

h) O-Z/Gedney Co.; Emerson.

i) Southwire Company, LLC

j) Western Tube and Conduit Corporation.

k) Wheatland Tube Co.

2. RMC:

a) GRS: Hot-dip galvanized: ANSI C80.1, UL 6.

b) RAC: ANSI C80.5, UL6A.

3. IMC: ANSI C80.6, UL 1242.

4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.

a) Fittings: Set-screw or Compression.

5. FMC: Aluminum or Zinc-coated steel: UL 1.

6. LFMC: Flexible steel raceway with PVC jacket: UL 360.

a) Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

a) ABB, Inc.

b) American Pipe and Plastics, Inc.

c) Anamet Electrical, Inc.

d) Atkore

e) Cantex Inc.

f) Carlon

g) Champion Fiberglass, Inc.

h) Electri-Flex Co.

i) Hubbell Inc. (Fittings)

j) IPEX USA, LLC.

k) Prime Conduit.

l) Southwire Corporation.

m) Superflex Ltd.

n) United Fiberglass of America, Inc.

2. RNC: Schedule 40 anelboeleeeijfsaoidjfsdfoijd 80 PVC: NEMA TC 2, UL 651.
    a) Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
    b) Fittings: match to tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
3. RTRC (Fiberglass): UL 2515 AG, NEMA TC 14; SW (Standard Wall)
4. Phenolic Conduit (RTRC) for use in UL 2196 2-Hour Fire Resistive systems: UL 2515 AG, NEMA TC 14
    a) Must be used as part of a UL-certified FHIT 2-hour listed fire resistive system.

C. Metal Wireways
1. Manufacturers:
    a) BEL Products, Inc.
    b) Cooper B-Line; Eaton.
    c) EPI-Electrical Enclosures
    d) Hoffman.
    e) Square D.
2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 1, 3R, 12, or 4X.
3. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
4. Wireway Covers:
    a) Screw-cover type
5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.

D. Nonmetallic Wireways
1. Manufacturers:
    a) ABB, Inc.
    b) Enduro Composite Systems
    c) Hoffman.

2. Description: Fiberglass reinforced polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Gasketed cover with oil-resistant gasket material.

   a) Corrosion resistant captive screws

3. Description: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

4. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

5. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.02 BOXES, ENCLOSURES AND CABINETS

A. General

1. Manufacturers:

   a) ABB, Inc.

   b) American Midwest Power

   c) Appleton/O-Z Gedney Co.; Emerson.

   d) BEL Products, Inc.

   e) Cooper Crouse-Hinds; Eaton.

   f) Erickson Electrical Equipment Co.

   g) FSR, Inc.

   h) Hoffman.

   i) Hubbell, Inc.

   j) Legrand.

   k) Molex; Koch Industries.

   l) Robroy Industries, Inc.; Enclosure Division.

   m) Spring City Electrical Manufacturing Co.

2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.

a) List and label as complying with UL 514A for non-hazardous locations;.

b) List and label as complying with UL 886 for hazardous locations, where required.

3. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.

4. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

5. Boxes for Ganged Devices: Use multi-gang boxes of single-piece construction. Do not use field-connected gangable boxes.

6. Minimum Box Size, Unless Otherwise Indicated:

a) Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

b) Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

7. Do not use "through-wall" boxes designed for access from both sides of wall.

8. Wall Plates: Comply with Division 26 Section “Wiring Devices”.

C. Boxes for telephone, data, telecommunications and audio-video outlets, refer to:

1. Division 27 Section "Common Work Results for Communications."

D. Junction and Pull Boxes Larger Than 100 cubic inches:

1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.

2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron with gasketed cover.

3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

E. Floor Boxes

1. General:

a) Floor Box Schedule on drawings: Refer to Drawings for specific floor box requirements.

b) Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.

c) Provide a complete Floor Box Assembly.

d) UL514A listed for scrub water exclusion for all floor types.

e) Floor boxes for on or below grade installation shall be watertight, fully adjustable cast iron or epoxy coated steel.

f) Floor boxes for above grade shall be concrete-tight, fully adjustable, stamped galvanized steel box.

g) Provide shallow boxes where necessitated by slab depth. Conduits shown on plans are minimum size, select appropriate floor box based on slab type, thickness, and minimum conduit size.

h) Non-metallic PVC construction, watertight floor boxes may be used where specifically listed in schedule or specified on drawings.

i) Receptacles:

1) Provide receptacles complying with requirement of Division 26 “Wiring Devices”.

2) Duplex: Include a minimum of one Convenience Receptacle, or quantity as indicated on schedule, with features as noted on schedule.

3) GFCI: Include quantity of GFCI Receptacles as indicated on schedule, with features as noted on schedule.

4) Isolated Ground: Include quantity of Isolated Ground Receptacle as indicated on schedule, with features as noted on schedule.

5) Special: Include quantity of Special/Miscellaneous Devices as indicated on schedule, with features as noted on schedule.

j) Communications:

1) Provide dedicated mounting space (gang) for each communication device type indicated on schedule. Include

provisions for mounting devices in accordance with the requirements of the communication systems provider.

2) The following items are not provided per this specification section:

(a) Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section “Communications Horizontal Cabling”. Coordinate all other Assembly components to ensure compatibility.

(b) Audio Video custom termination plates and connectors shall be provided per Division 27 Section “Audio Video Systems” and/or “Audio Video Systems Equipment”. Coordinate all other assembly components to ensure compatibility.

F. Poke-Through Outlets

1. General:

a) Poke-Through Schedule on drawings: Refer to Drawings for specific floor box requirements.

b) Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.

c) Provide a complete Poke through assembly.

d) UL listed for scrub water exclusion for all floor types.

e) UL listed and UL Fire Classified, with one- to four-hour fire rating, as required by floor rating and type.

2. Receptacles:

a) Provide receptacles complying with requirement of Division 26 “Wiring Devices”.

b) Duplex: Include a minimum of one Convenience Receptacle, or quantity as indicated on schedule, with features as noted on schedule.

c) GFCI: Include quantity of GFCI Receptacles as indicated on schedule, with features as noted on schedule.

3. Communications:

a) Provide dedicated mounting space (gang) for each communication device type indicated on schedule. Include provisions for mounting devices in accordance with the requirements of the communication

systems provider. Communication devices to be defined and provided under specification of other divisions.

G. Cabinets and Enclosures

1. General:

a) Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.

b) Cabinets and Hinged-Cover Enclosures, Other than junction and pull boxes: shall be keyed. Provide 2 keys for each enclosure.

c) NeMA 250 Environment ratings:

1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; manufacturer's standard ANSI 61 gray polyester powder finish inside and out; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.

2) NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; manufacturer's standard ANSI 61 gray polyester powder finish inside and out; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.

d) Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.

e) Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.

f) Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring.

g) Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.03 FACTORY FINISHES

A. Interior Finish: All interior components shall be factory finished; manufacturer’s standard grey unless otherwise noted.

B. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard paint, applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Install in accordance with manufacturer's instructions

3.02 RACEWAYS

A. General

1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).
    a) 1/2 inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
    b) 3/8 inch flexible conduit may be used for light fixture whips.
3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
5. Install grounding bushings or other code compliant connections on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

10. Install raceways:

    a) To meet the requirements of the structure and the requirements of all other Work on the Project.

    b) To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

    c) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.

    d) Parallel or perpendicular to building lines or column lines.

    e) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

11. Raceways Embedded in Slabs:

    a) Raceways may only be embedded in concrete slabs with written permission from and only where directed, by the Structural Engineer.

    b) Install in middle 1/3 of slab thickness, where practical. At a minimum, concrete shall provide at least 2 inches of concrete cover for raceways.

    c) Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

    d) Space raceways laterally to prevent voids in concrete.

    e) Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

12. Where masonry, brick, CMU or concrete walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.

13. Where masonry, brick, CMU or concrete walls in public spaces are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.

14. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section “Hangers and Supports for Electrical Systems”. Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.

15. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:

    a) Attach single raceway directly to structural steel with beam clamps.

    b) Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.

    c) Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.

    d) Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.

    e) Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.

    f) Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.

    g) Support conductors in vertical raceway in accordance with NFPA 70 requirements.

    h) Cross-brace suspended raceway to prevent lateral movement during seismic activity.

    i) Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.

16. Install electrically- and physically-continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends

smooth and even, without flattening raceway or flakingfirefdfdfE the finish.

17. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.

18. Align and install raceway terminations true and plumb.

19. Complete raceway installation before starting conductor installation.

20. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

21. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.

22. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Contract Administrator, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Contract Administrator, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

23. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

    a) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.

    b) Where otherwise required by NFPA 70.

24. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment as required by other requirements of the construction documents. FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

25. Maintain 2" minimum spacing from bottom of roof deck to prevent raceway penetrations from above.

26. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.

27. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.

28. Install all underground conduits/raceways, outside the building footprint, a minimum of 24" below the bottom of paving/grade, unless noted otherwise, where practicable.

29. Install all underground conduits/raceways underneath building footprint slab-on-grade a minimum of 12" below bottom of slab, unless noted otherwise, where practicable.

30. Where conduits are subject to earth movement by settlement or frost, provide expansion fittings to prevent damage to enclosed conductors or connected equipment.

B. RMC

1. Use GRS or IMC in the following areas:

   a) Where indicated.

   b) For Emergency Feeders.

   c) Exterior applications where above grade and exposed.

   d) Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.

   e) All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.

   f) Interior spaces where exposed to damage. Includes but is not limited to the following areas.

      1) Corridors used for traffic of mechanized carts, forklifts and pallet handling units.

2. Use RAC in the following areas:

   a) Indoors above grade.

   b) Interior wet or damp locations.

   c) For circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3. Do not use RAC:

   a) Below grade.

   b) Imbedded in concrete or other areas corrosive to RAC.

C. EMT

1. Use EMT in the following areas:
    a) Where indicated.
    b) Interior concealed locations for:
        1) Branch circuits.
        2) Feeders.
        3) Emergency branch circuits.
        4) Low-voltage control, security, and fire alarm circuits
    c) Exposed where not subject to physical damage
        1) Mechanical rooms
2. Do not use EMT:
    a) Below grade.
    b) In exterior applications when exposed.

D. FMC and LFMC

1. Use FMC or LFMC:
    a) For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
    b) From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
    c) Use FMC only in dry locations.
    d) Use LFMC in damp, wet, corrosive, outdoor locations, and food service and kitchen areas.
2. Do not use FMC or LFMC:
    a) For branch circuits, homeruns or feeders.
    b) In lengths exceeding 6 feet.

E. RNC

1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per NFPA 70, to accommodate thermal expansion in straight runs.
3. RNC is only allowed to be used in the following locations:
    a) Where specifically indicated.

1) If an adopted code prevents use of RNC in a location where the contract documents specifically allows its use, contractor shall utilize other types of conduit allowed by the specification.

2) Allowed does not mean required.

b) Underground, single and grouped, in lieu of GRS or IMC, when indicated.

1) Direct buried

2) Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).

3.03 RACEWAY FITTINGS:

A. Compatible with raceways and suitable for use and location.

B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.

C. Join raceways with fittings designed and approved for that purpose and make joints tight.

D. Use insulating bushings to protect conductors at raceway terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

3.04 WIREWAYS

A. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Close ends of wireway and unused raceway openings.

3.05 BOXES

A. General

1. Verify locations of device boxes prior to rough in.
2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
4. Install boxes to preserve fire ratings of walls, floors, and ceilings.
5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
6. Support boxes independently of raceway.
7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
8. Adjust flush-mounted boxes to make front edges flush with finished wall material.
9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. NEMA Enclosure ratings, Suitable for the environment in which it is installed. At a minimum, provide the following ratings:
1. NEMA 250, type 3R
    a) Provide at exterior locations
2. NEMA 250, type 1
    a) Provide at interior and dry locations

C. Outlet Boxes
1. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes.
2. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
3. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in

accessible locations and do not install outlets above ducts or behind furring.

4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
6. Use cast aluminum boxes where aluminum rigid metal conduit is used.
7. Use nonmetallic boxes where exposed rigid PVC conduit is used.
8. Use suitable concrete type boxes where flush-mounted in concrete.
9. Use suitable masonry type boxes where flush-mounted in masonry walls.
10. Use raised covers suitable for the type of wall construction and device configuration where required.
11. Use shallow boxes where required by the type of wall construction.
12. Install extension and plaster rings as required by NFPA 70.
13. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
14. Do not exceed allowable fill per NFPA 70.
15. Where multiple devices are shown grouped together, gang mount with a common cover plate.

D. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.
2. Provide boxes set flush in painted walls or ceilings with primer coated cover.
3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.
4. Boxes for exterior use shall be:
    a) PVC with a UV-stabilized PVC cover sealed and gasketed watertight.
    b) Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
    c) Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.

d) Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

E. Floor Boxes

1. Use cast or non-metallic floor boxes for installations in slab on grade. Unless otherwise indicated, formed steel boxes are acceptable for slabs above grade.

2. Set metal floor boxes level and flush with finished floor surface.

3. Set non-metallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.06 CABINETS AND ENCLOSURES

A. Unless otherwise indicated on the Drawings, provide

1. NEMA 1 construction for indoor, dry locations

2. NEMA 12 for indoor, damp and dusty locations

3. NEMA 3R for outdoor locations

B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.

C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.

E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.

F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

3.07 IDENTIFICATION

A. Refer to Division 26 Section “Identification for Electrical Systems” for identification materials.

B. Raceway Identification

1. Conduit and raceways are to be color coded for ease of identification. Where a facility standard already exists, that shall be followed. Where no standard exists for color-coding, provide in accordance with table below.

2. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Use the following means of identification:

   a) Spray paint at boxes .

3. Color for Printed Legend:

   a) Power Circuits: Black letters on an orange field.

   b) Legend: Indicate system or service and voltage, if applicable

C. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:

1. Fire Alarm System: Red.

2. Fire-Suppression Supervisory and Control System: Red and yellow.

3. Combined Fire Alarm and Security System: Red and blue.

4. Security System: Blue and yellow.

5. Mechanical and Electrical Supervisory System: Green and blue.

6. Telecommunication System: Green and yellow.

7. Control Wiring: Green and red.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

E. Junction Boxes and Pull Boxes:

1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2. The junction box where a homerun ends and the circuit is distributed shall be marked. Junction boxes shall be marked approximately every 100 feet along homerun path to panel.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Cable trays and accessories for the following types:

1. Steel
2. Aluminum
3. Stainless-steel

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the arrangement of cable tray and supports with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others. Coordinate the work with other trades to avoid installation of obstructions within cable tray required clearances.

B. Coordinate arrangement of cable tray with the dimensions and clearance requirements of the actual products to be installed.

C. Coordinate the work with placement of supports, anchors, etc. required for mounting.

D. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

E. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

F. Cables shall not be installed within cable trays until associated raceway and cable tray system is complete.

G. Refer to Division 27 section “Common Work Results for Communications” for requirements for cable trays containing communication cabling.

1.03 SUBMITTALS

A. Product Data: Include data indicating dimensions, accessories and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Field quality-control reports.

D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual cable tray routing and locations of supports.

E. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray system and associated components and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

B. Handle products carefully to avoid damage to finish.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide new cable tray system consisting of all required components, fittings, supports, accessories, etc. as necessary for a complete system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide cable tray system to meet span/load ratings in accordance with NEMA VE 1 for metal cable tray systems, or NEMA FG 1 for fiberglass cable tray systems, with safety factor of 1.5 and working load. Account for additional concentrated static loads at supports where required and allowed per NFPA 70.

D. Unless otherwise indicated, specified widths and loading depths are nominal values according to NEMA VE 1 for metal cable tray systems or NEMA FG 1 for fiberglass cable tray systems with applicable allowable tolerances.

2.02 MANUFACTURERS

A. Manufacturers:

1. ABB, Inc.
2. Cablofil, a brand of Legrand North America, Inc.
3. Chalfant Manufacturing Company.
4. Cooper B-Line; Eaton.
5. Cope; a division of Atkore International.
6. Enduro Composites
7. Mono-Systems; Niedax Group
8. MPHusky.

2.03 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.

1. Mill galvanized before fabrication, complying with ASTM A 653/A 653M, G90 (Z275) coating; with hardware galvanized according to ASTM B 633.

B. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136 splice-plate fasteners, bolts, and screws.

C. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

1. Center-hanger supports may be used only when specifically indicated.

2.04 CABLE TRAY TYPE

A. Basket Cable Trays: Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).

1. Cable tray width and loading depth shall be as indicated on drawings.
2. Straight sections shall be supplied in 10 foot lengths.

B. Ladder Cable Trays:

1. Cable tray width and loading depth shall be as indicated on drawings.
2. Straight sections shall be supplied in 10 or 20 foot lengths.
3. Rung spacing of 6 inches.

C. Single Rail Cable Tray: Center rails and rungs with continuous square tube rungs with radius corners. Splice hangers shall be capable of acting as the support points for all-thread rod.

1. Cable tray width and loading depth shall be as indicated on drawings.

2. Straight sections shall be supplied in 10 foot lengths.

3. Rungs shall be spaced every 12 inches.

2.05 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: Solid type of same materials and finishes as cable tray.

C. Barrier Strips: Same materials and finishes as cable tray; with supports sufficient to resist cable pulling weight applied during installation.

D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.06 SOURCE QUALITY CONTROL

A. Perform factory design and production tests according to NEMA VE 1 for metal cable tray systems or NEMA FG 1 for fiberglass cable tray systems.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Verify that conditions are satisfactory for installation prior to starting work.

B. Install in accordance with manufacturer’s instructions.

3.02 CABLE TRAY INSTALLATION

A. Remove burrs and sharp edges from cable trays.

B. Install cable tray in accordance with NECA 1 and comply with recommendations in NEMA VE 2.

C. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

D. Arrange cable tray to provide required clearances and maintain cable access.

1. Minimum Clearance Above and Adjacent to Cable Tray: 12 inches.

E. Fasten cable tray supports to building structure.

1. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.
2. Place supports so that spans do not exceed maximum spans limits set by the manufacturer.
3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
4. Support bus assembly to prevent twisting from eccentric loading.
5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
6. Locate and install supports according to NEMA VE 1 for metal cable tray systems or NEMA FG 1 for fiberglass cable tray systems.

F. Cable Tray Movement Provisions:

1. Provide suitable expansion fittings where cable tray is subject to movement, including but not limited to:
   a) Where cable tray crosses structural joints intended for expansion.
   b) Long straight cable tray runs in accordance with NEMA VE 2.
   c) Use expansion guides in lieu of hold-down clamps where prescribed in NEMA VE 2.
   d) Set gaps for expansion fittings in accordance with NEMA VE 2.

G. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

H. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in to NEMA VE 1 for metal cable tray systems or NEMA FG 1 for fiberglass cable tray systems. Space connectors and set gaps according to applicable standard.

I. Make changes in direction and elevation using standard fittings.

J. Make cable tray connections using standard fittings.

K. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

L. Workspace: Install cable trays with enough space to permit access for installing cables.

M. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5,000, and 15,000 Volts.

N. Provide end closures at unconnected ends of cable tray runs.

O. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.03 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. Use suitable drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.

E. Use suitable cable support fittings for long vertical cable tray runs with heavy cables.

F. Install covers after installation of cable is completed.

3.04 WARNING SIGNS

A. Legend: "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."

3.05 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions and comply with NEMA VE 2 where more stringent.

B. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70. Refer to Division 26 section “Grounding and Bonding for Electrical Systems” for additional requirements.

3.06 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

3.07 PROTECTION

A. Protect installed cable trays.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.
3. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Raceways, fittings and duct accessories for underground electrical site distribution

1.02 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit

1.03 ADMINISTRATIVE REQUIREMENTS

A. COORDINATION

1. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
2. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Contract Administrator.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:
   a) Raceways, raceway fittings, separators, duct-bank materials, boxes, solvent cement, and warning tape.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that Indicate dimensions from finished grade or other fixed structural elements.

1.05 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

2. Marked for intended use.

C. Comply with NFPA 70 and ANSI C2.

D. Test and inspect pre-cast concrete utility structures according to ASTM C 1037.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.

B. Store pre-cast and other factory –fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.

C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

PART 2 - PRODUCTS

2.01 RACEWAYS, FITTINGS AND DUCT ACCESSORIES

A. Metal Conduit

1. Available Manufacturers:

a) ABB, Inc.

b) American Conduit

c) Atkore

d) Nucor Tubular Products

e) O-Z/Gedney; Emerson

f) Western Tube and Conduit Corporation

g) Wheatland Tube Co.

2. RMC:

a) GRS: Hot-dip galvanized: ANSI C80.1, UL 6

3. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.040 inches (1 mm), minimum.

4. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway and Tubing

1. Manufacturers:

a) ABB, Inc.

b) American Pipe and Plastics, Inc.

c) Anamet Electrical, Inc.

d) Atkore

e) Cantex Inc.

f) Carlon

g) Champion Fiberglass, Inc.

h) IPEX USA,

i) Prime Conduit

j) Southwire Corporation

k) United Fiberglass of America, Inc.

2. RNC: Schedule 40 (type EPC-40-PVC) PVC: NEMA TC 2, UL 651.

a) Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

3. RTRC: UL 2420 UG NEMA TC 14 SW (Standard Wall), HW (Heavy Wall) or XW (Extra Heavy Wall.)

C. Duct Accessories

1. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.

2. Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive and inspect precast or premanufactured equipment.

B. Examine components before installation. Reject components that are damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install all components per manufacturer's recommendations.

3.03 UNDERGROUND DUCT APPLICATION

3.04 EARTHWORK

A. Excavation and Backfilling: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses and "Plants"

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.05 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48-inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10-inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to PVC coated rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section ”Common Work Results for Electrical.”

F. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

3.06 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

3.07 INSTALLATION ACCEPTANCE

A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wood test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct.

B. Test duct bank, manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections.

C. Measure and report ground resistance as specified in Division 26 Section “Grounding and Bonding for Electrical Systems.” Correct any deficiencies and retest as specified above.

D. Clean internal surfaces of manholes (including sumps) and handholes and remove foreign materials.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following:

1. Nameplates.
2. Labels for raceways and metal-clad cable.
3. Labels for junction boxes and pull boxes.
4. Labels for wiring devices and lighting control devices.
5. Markers for conductors, and control cables.
6. Tags.
7. Underground-line warning tape.
8. Warning labels and signs.
9. Arc Flash Warning Labels.
10. Instruction signs.
11. Miscellaneous identification products.
12. Painted Identification.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.

B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

C. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.03 SUBMITTALS

A. Product Data: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements" for each electrical identification product indicated:

1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.04 QUALITY ASSURANCE

A. Electrical Equipment, Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.

2. Marked for intended use.

B. Comply with ANSI A13.1 and ANSI C2.

C. Comply with requirements of NFPA 70.

D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS

2.01 GENERAL

A. Location, text, and method of identification to be used is noted in individual sections. Refer to other sections for additional identification requirements.

2.02 NAMEPLATES

A. Comply with UL RP 9691, Recommended Practice for Nameplates for Use in Electrical Installations.

B. Engraved, Laminated Acrylic or Melamine Label: Non-conductive phenolic with beveled edges.

1. Adhesive backed.

2. Minimum 1/16 inch (1.6 mm) thick for nameplates with either dimension greater than 4 inches (102 mm) and 1/8 inch (3.2 mm) thick for larger sizes.

C. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

D. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

E. Text: Minimum text height shall be 1/8 inch (3.2 mm) unless otherwise required by local jurisdiction or owner standards. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

F. Colors:

1. Normal systems - white letters on a black background.
2. Emergency systems - white letters on a red background.

G. Label Requirements:

1. Service Equipment Label

   LINE 1: NOMINAL VOLTAGE AND FREQUENCY IN HERTZ

   LINE 2: SERVICE EQUIPMENT BUS RATING IN AMPS

   LINE 3: SCCR OF SERVICE EQUIPMENT IN AMPS

   LINE 4: MAXIMUM AVAILABLE FAULT CURRENT IN AMPS

   LINE 5: DATE CALCULATED

   EXAMPLE:

   208Y/120V, 60HZ

   800A

   SCCR = 65,000A

   MAX AVAILABLE FAULT CURRENT = 58,815A

   CALCULATED: 01/01/2018

2. Panelboard/Switchboard Label:

   LINE 1: PANELBOARD/SWITCHBOARD DESIGNATION

   LINE 2: VOLTAGE, PHASE, WIRES, AMPS

   LINE 3: FED FROM “ “

   EXAMPLES:

   H1A

   480Y/277V, 3PH, 4W, 200A

   FED FROM MDB

   L1A

   208Y/120V, 3PH, 4W, 225A

   FED FROM H1A VIA XFMR T1

3. Transformer Label:

   LINE 1: TRANSFORMER DESIGNATION

   LINE 2: FED FROM “ “

   LINE 3: SUPPLIES “ “

   EXAMPLE:

T1

FED FROM H1A

SUPPLIES L1A

4. Disconnect Switch Label:

LINE 1: DESIGNATION OF EQUIPMENT SERVED BY DISCONNECT

LINE 2: VOLTAGE, PHASE, WIRES, AMPS

LINE 3: FED FROM " "

EXAMPLES:

WATER HEATER WH1

480V, 3PH, 3W, 100A

FED FROM MDB

2.03 LABELS FOR RACEWAYS AND METAL-CLAD CABLE

A. Factory Painted Raceways:

1. Metal Raceways: Continuous, rust-inhibiting paint factory applied.
2. Non-Metallic Raceways: Factory dyed or colored PVC sleeve.

B. Factory Painted Metal-Clad Cable: 2-inch wide, factory painted bands at a maximum of 6-foot on center spacing.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.04 LABELS FOR JUNCTION BOXES AND PULL BOXES

A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.05 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

B. Engraved cover plates: Provide with white letters. White or ivory cover plates shall have black letters.

C. Permanent Ink: Permanent, waterproof, black ink marker, hand printed legibly.

2.06 MARKERS FOR CONDUCTOR AND CONTROL CABLES

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.07 TAGS

A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.08 UNDERGROUND-LINE WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color: Tape for Buried Power Lines: Black text on red background.

2.09 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.

B. Self-Adhesive Warning Labels: Factory pre-printed or machine-printed multicolor self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

1. Use thermal transfer process printing machines and accessories recommended by label manufacturer.

2. Do not use labels designed to be completed using handwritten text.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.

1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.10 ARC FLASH WARNING LABELS

A. General: All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system. Refer to Division 26 section “Power System Studies” for additional requirements.

B. Materials: Use machine-printed, high adhesion, polyester label; UV, chemical, water, heat, and abrasion resistant, for each work location analyzed.

C. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer. Labels shall be machine printed, with no field markings. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

D. Minimum Size: 3.5 inch by 5 inch (89 mm by 127 mm), unless otherwise noted by Owner.

E. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment. The label shall include the following information, at a minimum:

1. Location designation

2. Nominal voltage

3. Available fault current
4. Limited approach boundary
5. Arc flash boundary
6. Restricted approach boundary
7. Hazard risk category
8. Incident energy
9. Working distance
10. Site-specific PPE (personnel protective equipment) requirements.
11. Date calculations were performed.
12. Engineering report number, revision number and issue date.

2.11 INSTRUCTION SIGNS

A. Engraved, Laminated Acrylic or Melamine plastic: Non-conductive phenolic. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

1. Minimum 1/16 inch (1.6 mm) thick for nameplates with either dimension greater than 4 inches (102 mm) and 1/8 inch (3.2 mm) thick for larger sizes.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
4. Normal systems: Engraved legend with white letters on black face.
5. Essential Systems: Engraved legend with white letters on red face.

B. Stainless Steel Nameplates: Minimum thickness of 1/32 inch ; engraved or laser-etched text.

C. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

D. Colors:

1. General Information and Operating Instructions – Black letters on white background.
2. Normal systems - white letters on a black background.
3. Emergency systems - white letters on a red background.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Fasteners for Nameplates, Labels and Signs

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

2.13 PAINTED IDENTIFICATION

A. Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
   a) Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior concrete and masonry primer.
      2) Finish Coats: Exterior semi-gloss acrylic enamel.
2. Exterior Concrete Unit Masonry:
   a) Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Exterior semi-gloss acrylic enamel.
3. Exterior Ferrous Metal:
   a) Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior ferrous-metal primer.
      2) Finish Coats: Exterior semi-gloss alkyd enamel.
4. Exterior Zinc-Coated Metal (Except Raceways):
   a) Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior zinc-coated metal primer.
      2) Finish Coats: Exterior semi-gloss alkyd enamel.
5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
   a) Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior concrete and masonry primer.

2) Finish Coats: Interior semi-gloss alkyd enamel.

6. Interior Concrete Unit Masonry:

a) Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

1) Block Filler: Concrete unit masonry block filler.

2) Finish Coats: Interior semi-gloss acrylic enamel.

7. Interior Gypsum Board:

a) Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior gypsum board primer.

2) Finish Coats: Interior semi-gloss acrylic enamel.

8. Interior Ferrous Metal:

a) Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior ferrous-metal primer.

2) Finish Coats: Interior semi-gloss acrylic enamel.

9. Interior Zinc-Coated Metal (Except Raceways):

a) Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior zinc-coated metal primer.

2) Finish Coats: Interior semi-gloss acrylic enamel.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify identity of each item before installing identification products.

B. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

C. Provide identification product listed for the location in which it is to be installed.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. For surfaces that require finish work, apply identification devices after completing finish work. Do not install identification products until final surface finishes and painting are complete.

C. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed. Replace labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

D. Location: Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance without interference with operation and maintenance of equipment. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

1. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

F. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.

1. Indoor Clean, Dry Locations: Use plastic nameplates, unless noted otherwise.
2. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.

G. Install identification products centered, level, and parallel with lines of item being identified.

H. Mark all handwritten text, where permitted, to be neat and legible.

I. For refrigeration systems: Neatly bundle circuits and clearly tag and label each circuit with panelboard, branch circuit designation and refrigeration system number at each termination.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes computer-based studies for the following:

1. Short-circuit analysis.
2. Protective device coordination study.
3. Arc flash and shock risk assessment, including arc flash hazard labels.

B. Criteria for selection and adjustment of equipment and associated protective devices not specified in this section, as determined by the studies performed.

1.02 ADMINISTRATIVE REQUIREMENTS

A. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the short-circuit study. Device ratings for furnished equipment shall be as required by the results of the short-circuit study at no additional cost.

B. Coordination:

1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
2. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Sequencing:

1. Initial Study:
   a) Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. Do not order equipment until matching study reports and product submittals have both been evaluated by the Contract Administrator.
   b) If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the Contractor at no additional cost to the project.
2. Final Study:

a) Study must be completed and submitted for review prior to substantial completion. Do not print arc flash labels until final study has been evaluated by the Contract Administrator.

b) Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels.

D. Scheduling:

1. Arrange access to existing facility for data collection with Owner.

2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner. Refer to Division 26 section “General Electrical Requirements” for additional requirements.

1.03 SUBMITTALS

A. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Product data for computer software program to be used for studies.

2. Include characteristic time-current trip curves for protective devices.

3. Include impedance data for busway.

4. Include impedance data for engine generators.

5. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

6. Include documentation of listed series ratings upon request.

7. Identify modifications made in accordance with studies to meet the results of the study.

B. Electronic files, in an SKM-compatible format, of the time-current characteristic curves for every different overcurrent device used in the reports.

C. Product Certificates: For coordination-study and short-circuit-study computer software programs, certifying compliance with IEEE 399.

D. Qualification Data:

1. Study Preparer Specialist qualifications.

2. Field Testing Agency qualifications.

E. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

F. Other Action Submittals:

1. Initial Study report, stamped or sealed and signed by study preparer, including:
    a) Cover page including date of study, study methodology, assumptions made and software products used.
    b) Study input data, including completed computer program input data sheets.
    c) Short-circuit study report.
    d) Equipment evaluation report.
    e) Coordination-study report.
    f) Settings report.
2. Final Study report, stamped or sealed and signed by study preparer, including:
    a) Cover page including date of study, study methodology, assumptions made, software products used, and summary of changes between initial and final studies.
    b) Study input data, including completed computer program input data sheets.
    c) Short circuit study report.
    d) Equipment evaluation report.
    e) Coordination-study report.
    f) Settings report.
    g) Arc-Flash Hazard Analysis, including labels.
3. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

G. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:
1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.
3. Include copies of previous studies and existing drawings that were obtained during the data collection phase of the study.

1.04 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Study Preparer Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state in which the Project is located, shall be responsible for the study and with a minimum five years experience in the preparation of studies of similar type and complexity using the specified computer software. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 399 for general study procedures.

D. Comply with IEEE 141, 242 and 551 for short-circuit currents and coordination time intervals.

E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, use the latest commercially available computer software programs utilizing the specified methodologies developed by one of the following:

1. CYME International, Inc. (Eaton): www.cyme.com.
2. EasyPower - Part of Bentley Systems: www.easypower.com.
3. ETAP/Operation Technology, Inc.: etap.com.
4. Power Analytics Corporation: www.poweranalytics.com.
5. SKM Systems Analysis, Inc.: www.skm.com

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of short-circuit-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Zero-Sequence current.
2. Arcing faults.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

C. Short-circuit study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.

D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final short-circuit and coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.02 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths and operating modes on both sides of any transfer switch, contactor or circuit breaker.

B. Operating modes shall include, where applicable:

1. Utility as a source.
2. Generator as a source.
3. Maintenance settings.

C. Components include, but are not limited to:

1. Switchboards
2. Distribution Panelboards
3. Panelboards
4. Air Handling Equipment
5. Roof Top HVAC equipment
6. Elevator controllers

D. Non-linear load equipment to be included in harmonic study shall include, but not be limited to:

1. LED Lighting

2. Chiller controllers
3. Mechanical and plumbing system variable frequency drives
4. Uninterruptible power supplies larger than 3kVA
5. Elevator controllers

3.03 POWER SYSTEM DATA FOR STUDIES

A. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling. Gather and tabulate the following input data to support studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:
    a) Indicate load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    b) Protective Devices: Include circuit-breaker and fuse-current ratings and types;
    c) Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
    d) Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio. kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    e) Generators: Include manufacturer/model, kilovolt amperes, size, voltage, and source impedance.
    f) Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length.
    g) Busways: Include bus material, ampacity and impedance.
    h) Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
    i) Variable frequency drive rating, manufacturer, and model series.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

a) Special load considerations, including starting inrush currents and frequent starting and stopping.

b) Magnetic inrush current overload capabilities of transformers.

c) Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d) Ratings, types, and settings of utility company's overcurrent protective devices.

e) Special overcurrent protective device settings or types stipulated by utility company.

f) Protective Devices:

1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).

2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

g) Time-current-characteristic curves of devices indicated to be coordinated.

h) Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j) Panelboards, switchboards, motor-control center ampacity, and interrupting ratings in amperes rms symmetrical.

3.04 SHORT-CIRCUIT STUDY

A. Source Impedance: Utility company's fault current contribution as provided by utility.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operation modes that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.

2. Low-Voltage Fuses: IEEE C37.46.

3. Circuit Breakers: IEEE C37.13.

F. Study Report:

1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.

2. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.

G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing short-circuit current ratings of these devices with calculated short-circuit current momentary and interrupting duties. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3.05 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of the short-circuit study and approved computer software program. Comply with IEEE 399.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

D. Analyze alternate scenarios considering known operating modes.

E. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a) Inrush current when first energized.

b) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

   a) Device tag.

   b) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

   c) Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.

   d) Fuse-current rating and type.

   e) Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

   a) For protective Devices:

      1) Device tags.

      2) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.

      3) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.

      4) Include ground fault pickup and delay.

      5) Include fuse ratings.

   b) Voltage and current ratio for curves.

   c) Three-phase and single-phase damage points for each transformer.

   d) No damage, melting, and clearing curves for fuses.

   e) Cable damage curves.

   f) Generator full load current, overload curves, decrement curves and short-circuit withstand points.

g) Transformer inrush points.

h) Maximum fault current cutoff point.

i) Capacitor full load current and damage curves.

3. Include conclusions and recommendations.

4. Completed data sheets for setting of overcurrent protective devices.

5. For emergency, legally required standby and health care essential power systems, such systems must selectively coordinate to the values indicated below unless local amendments to the National Electrical Code require a different value.

a) Emergency (NEC article 700) 0.01 seconds

b) Legally Required Standby (NEC article 701) 0.01 seconds

c) Elevator Systems (NEC article 620) 0.01 seconds

d) Health Care Essential Electrical Systems (NEC article 517)

1) Equipment Branch 0.10 seconds

2) Critical Branch 0.01 seconds

3) Life-Safety Branch 0.01 seconds

3.06 ARC-FLASH HAZARD ANALYSIS

A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies in accordance with IEEE 1584. Perform the analysis under worst-case arc-flash conditions for all modes of operation.

B. In addition to the requirements outlined in IEEE 1584, the study shall include all equipment rated less than 240 Volts fed by transformers less than 125 kVA in the calculations.

1. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.

2. For single-phase systems, the calculations may be performed assuming a three-phase system in accordance with IEEE 1584, yielding conservative results.

C. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.

D. Identify all locations and equipment to be included in the arc-flash hazard analysis:

1. Include a copy of the facility one-line in the report.

2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.
3. Calculate the arcing fault current flowing through each branch for each fault location.
4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
5. Select the working distances based on system voltage and equipment class.
6. Calculate the incident energy at each fault location at the prescribed working distance.
7. Determine the hazard/risk category (HRC) for the estimated incident energy.
8. Calculate the flash protection boundary at each fault location.
9. Document the assessment in reports and one-line diagrams.
10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.

E. Results of the arc-flash study shall be summarized in a final report containing the following:

1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
3. Descriptions of the modes of operation evaluated and identification of the worst case scenario used to evaluate equipment ratings.
4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
5. Required arc-flash labeling and placement of labels.
6. Conclusions and recommendations, including recommendations for reducing incident energy at locations where calculated maximum incident energy exceeds 8 calories per sq cm.

3.07 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

a) Verify that overcurrent protective devices meet parameters used in studies.

b) Adjust devices to values listed in final study results.

c) Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.08 INSTALLATION

A. Install arc flash warning labels. Refer to Division 26 section Identification for Electrical Systems for additional requirements.

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspect and test protective devices in accordance with the NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Overcurrent protection devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies protective device settings have been adjusted in accordance with the requirements of the study. Include notation of conflicts with or deviations made from the studies or the contract documents, deficiencies detected, remedial action taken, and observations after remedial action.

3.10 TRAINING

A. Provide training for Owner’s personnel on electrical safety pertaining to arc flash and shock hazards.

B. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.

C. Provide minimum of eight hours of training performed by a representative of the entity performing the study.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following lighting control devices:

1. Line-voltage dimming wall switches.
2. Line-voltage wall switch occupancy sensors.
3. Time switches.
4. Automatic load control relays.

1.02 DEFINITIONS

A. Acoustic Type: Occupancy sensor detection type that detects occupancy by listening for acoustic noises.

B. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.

C. DPDT: Double pole, double throw.

D. DPST: Double pole, single throw.

E. Dual-Technology Type: Occupancy sensor detection type that detects occupancy by using a combination of PIR and ultrasonic or acoustic detection technologies.

F. LED: Light-emitting diode.

G. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.

H. PIR Type: Passive infrared. Occupancy sensor detection type that detects occupancy by sensing a combination of infrared heat and movement.

I. SPST: Single pole, single throw.

J. Ultrasonic Type: Occupancy sensor detection type that detects occupancy by sensing a change in pattern of reflected ultrasonic energy.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product data for the following products:

1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.

C. Shop Drawings:

1. Occupancy sensors and photoelectric switches

a) Show installation details.

b) Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.

c) Interconnection diagrams showing field-installed wiring.

d) Include diagrams for power, signal, and control wiring.

e) For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:

1) Factory-generated occupancy sensor and photoelectric switch layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.

2) List of any deviations to this specification or Basis of Design products.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Occupancy sensors and photoelectric switches:

a) Manufacturer’s installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.

b) Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.

c) Manufacturer’s maintenance, including operating and adjustment instructions.

2. Timeclocks

a) Description of programmed timeclock settings at time of substantial completion.

3. Line-voltage wall box dimming switches

a) Provide operating instructions for each type of dimmer.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Occupancy sensors and photoelectric switches

1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.

2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.

3. Manufacturer shall test all equipment prior to shipment.

1.06 WARRANTY

A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL INFORMATION

A. PIR type requirements:

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

2. Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.

3. Sensor shall provide high immunity to false triggering from RFI and EMI.

4. Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.

B. Ultrasonic type requirements:

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

2. Detection Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHZ within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.

3. Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.

4. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.

C. Acoustic type requirements:

1. Detector Sensitivity: Acoustic type technology shall only be used as secondary to PIR in a Dual-Technology Type sensor. Specific sensitivity is based on PIR technology.

2. Sensors shall distinguish noises made by human activity (typing, talking, eating, etc.) and filter out noises made by the environment or building (HVAC, equipment, cars, etc.).

3. Acoustic technology shall enhance reliability and accuracy of PIR sensor.

D. Dual-Technology type requirements:

1. Dual-Technology sensors using ultrasonic technology shall have field-selectable controls on unit to determine if a particular technology or combination of technologies controls the on-off function.

2. Dual-Technology sensors using acoustic technology shall have the PIR technology initially detect motion and a combination of PIR and acoustic technologies shall keep the load on.

3. Sensitivity Adjustment: Separate for each sensing technology.

4. Different LED indicator colors for each sensing technology

5. PIR sensor component shall comply with all requirements listed under PIR type requirements.

6. Ultrasonic sensor component shall comply with all requirements listed under Ultrasonic Type requirements.

7. Acoustic sensor component shall comply with all requirements listed under Acoustic Type requirements.

2.02 LINE-VOLTAGE DIMMING WALL SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. Dimmer shall be suitable for dimmed load type of connected light fixture. Load types shall be as indicated on Drawings and confirmed per load type for connected luminaire as indicated in Light Fixture Schedule and approved light fixture and dimmer shop drawings.

2.03 LINE VOLTAGE WALL SWITCH OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for Sensors:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C), unless indicated elsewhere for specific model and application.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
    a) Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
    b) Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of the switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
5. Operation adjustment: Concealed, field-adjustable for auto-on or manual-on operation.
6. Time Delay adjustment:
    a) Concealed, field-adjustable.
    b) Time delay for de-energizing loads shall be adjustable with multiple increments from 30 seconds up to 30 minutes.
7. Adaptive technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false “off” switching.
8. Mounting: Single-gang wall box switch
9. Finish: Sensor finish shall be white.
10. Sensor:
    a) Vandal-resistant lens

b) Integral sliding blinders or pre-cut tape strips to block sensor views

c) Protrudes no greater than 0.50 inches from wall.

d) 180-degree field of view

e) Major and minor motion coverage patterns confirmed per Nema WD7 guidelines.

f) Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

11. Indicators:

a) LED indicator for visual detection of motion

b) audible and/or visual alerts for pending shut-off

12. Suitable for switching load types used, including LED, fluorescent, incandescent, magnetic and electronic low voltage and motor load types. UL listed and labeled, zero-cross relay, no minimum load requirement, ground wire.

13. Wall switch shall have no leakage of current to load and integral service switch to permit a maintained off for servicing of lamps for safety purposes

14. Buttons/Relays: Provide control relay and push button quantities as indicated by model listed in Lighting Control Device Schedule.

15. Restriction on leakage to grounding conductor.

a) For new construction: Dual-technology wall switch sensor shall have not more than 0.5ma leakage of current to ground per UL requirements. Provide and connect a neutral conductor to these devices.

2.04 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.

2. Intermatic, Inc.

3. Leviton Mfg. Company Inc.

4. Lithonia Lighting; Acuity Lighting Group, Inc.

5. Paragon Electric Co.; Invensys Climate Controls.

6. Square D; Schneider Electric.

7. TORK; NSI Industries.

8. Wattstopper; a Legrand Company.

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST.
2. Contact Rating: 30-A inductive or resistive, 240-V ac.
3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Circuitry: Allow connection of a photoelectric switch relay as substitute for on-off function of a program.
5. Astronomic Time: All channels.
6. Battery Backup: For schedules and time clock.

2.05 AUTOMATIC LOAD CONTROL RELAYS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. For control of emergency lighting circuits: Loss of normal power shall cause relay to automatically shunt emergency power to lighting circuit regardless of manual or automatic switch position. Emergency lighting circuit shall continue to operate at full power until normal power has been restored.
2. Coil Rating: 120 or 277 V, as indicated on Drawings.
3. Mounting: A 2-gang outlet box with separation barrier and plaster ring or a wall-mountable box with separate compartments. Mount per manufacturer's instructions.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL

1. Install devices and associated power packs and wiring in accordance with manufacturer's instructions and applicable codes.

B. LINE VOLTAGE WALL SWITCHES

1. Install dimming wall switches to achieve full rating specified on Lighting Control Device Schedule taking into account de-rating for ganging as instructed by the manufacturer.
2. Provide a separate grounded (neutral) conductor for each circuit controlled by a line voltage switch.

a) Do not share neutral conductor on load side of dimmers.

b) If neutral termination is not required for the device, cap conductor and tag as “Neutral for future use”.

C. OCCUPANCY/VACANCY SENSORS AND PHOTOELECTRIC SWITCHES

1. Arrange a pre-installation meeting with manufacturer’s factory authorized field representative, at Owner’s facility, to verify placement of sensors and installation criteria.

2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.

3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems and partition assemblies.

4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.

5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.

6. Install outdoor photoelectric switches with clear view of the northern sky unless noted otherwise on the Drawings.

7. Adjust settings of photoelectric switches to turn on lighting at illumination level indicated on the Drawings.

8. Install devices and auxiliary equipment in compliance with manufacturer’s instructions and recommendations.

9. Install relay units where concealed from view and where accessible.

10. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

11. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

D. TIME SWITCHES

1. Install time switches in locations as indicated on the Drawings.

2. Program time switches with current time and date information in accordance with manufacturer’s instructions.

3. Program timeclock settings as per Sequence of Operations on the Drawings. Confirm final timeclock settings with Owner prior to programming.

E. AUTOMATIC LOAD CONTROL RELAYS

1. When used with manual controls, install emergency shunt relay in separate enclosure adjacent to associated light switch. Label within enclosure the connected normal and emergency circuits.

2. When used with automatic controls, install where concealed from view in accessible ceiling near the automatic control device or wall mounted within electrical room. Label outlet box cover with connected normal and emergency circuits.

F. WIRING

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.02 IDENTIFICATION

A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer’s instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer’s installation instructions for each sensor model.

B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

B. Photoelectric switch Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project for this purpose.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1500 kVA:

1. Distribution transformers.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.03 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, technical certification sheets and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Transformer ratings including:
    a) kVA
    b) Primary and secondary voltage
    c) Taps
    d) Basic impulse level (BIL) for equipment over 600 volts
    e) Design impedance
    f) Insulation class and temperature rise
    g) Sound level.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

F. All transformers shall be UL listed and bear the UL label.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.01 GENERAL TRANSFORMER REQUIREMENTS

A. Manufacturers:

1. ACME Electric Corporation; Power Distribution Products Division
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. General Electric Company.
4. Hammond Company
5. Siemens Energy & Automation, Inc.
6. Sola/Hevi-Duty
7. Square D; Schneider Electric.

B. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

C. Cores: One leg per phase. Cores shall be constructed of high grade, non-aging silicon steel. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor or strap sized in accordance with UL and NEC requirements. The neutral shall be brought to a stud to facilitate the required external grounding of the secondary

D. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Aluminum.

E. Connections to transformers shall be by flexible metal conduit and using flexible couplings.

F. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

G. Wiring/Terminations:

1. Recommended external cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs.

2. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.

3. Lug kits shall be provided by the Manufacturer of the transformer.

2.02 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Enclosures: Unless otherwise specified, transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. Enclosures shall have a baked polyester powder coat finish-gray in color and suitable for interior or exterior applications. Enclosures shall be constructed so that there are no exposed live parts. Enclosures shall have a removable front cover to allow access to internal parts and wiring terminations

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

2. Transformer locations:

a) Dry locations:

1) Ventilated.

2) NEMA 250, Type 2.

3. The maximum temperature of the enclosure shall not exceed 90 degrees C.

4. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

C. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 61 gray.

D. Taps

1. Three-phase Transformers smaller than 24 kVA and all single phase transformers:

a) One 5 percent tap above and one 5 percent tap below normal full capacity.

2. Transformers 25 kVA through 500 kVA:

a) Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

3. Transformers 501 kVA and Larger:

a) Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity manufacturer’s standard tap configuration.

E. Insulation Class for transformers less than 15 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

F. Insulation Class for transformers 15 kVA and larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

G. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment" efficiency levels.

2. Tested in accordance with federal law 10 CFR Part 431.

H. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

2. Indicate value of K-factor on transformer nameplate.

3. K-Factor rated transformers shall have an impedance range of 3% to 5%, and shall have a minimum reactance of 2% in order to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

4. 115 degree C temperature rise.

5. All cores to be constructed with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent core overheating and excessive sound level caused by harmonic voltage distortion.

6. Transformers shall be common core construction. Transformers utilizing more than one core, or Scott-T connections, shall not be acceptable.

7. Three-phase transformer secondary neutral terminals shall be sized for 200% of the secondary phase current.

8. The transformer shall be mounted on vibration absorbing pads.

I. Mounting Methods.

1. Transformers 75 KVA and larger shall be floor mounted unless indicated otherwise. Transformers 45 KVA and smaller may be wall mounted where wall construction is suitable for the load. Floor mounted transformers shall be securely bolted to a 4 inch housekeeping pad with vibration isolation pads. Wall mounted or suspended transformers shall have a means of isolating vibration from the support.

2. Transformers up through 1000 KVA shall be mounted on elastomeric vibration isolation pads. Pad shall be constructed of neoprene, rubber, glass fiber, or a combination thereof. Pads shall be "ribbed" or "waffled" in texture. Pads shall be selected for smallest durometer (hardness), preferably less than 50. Deflection of pad shall be .25" static minimum. Stack pads until the desired deflection is achieved.

3. Wall Mounting: Manufacturer's standard brackets.

4. Suspended Mounting: See transformer mounting detail on plans.

J. Low-Sound-Level Requirements: Maximum sound levels (NEMA ST 20), when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA

2. 10 to 50 kVA: 45 dBA

3. 51 to 150 kVA: 50 dBA

4. 151 to 300 kVA: 55 dBA

5. 301 to 500 kVA: 60 dBA

6. 501 to 700 kVA: 62 dBA

7. 701 to 1000 kVA: 64 dBA

8. 1001 to 1500 kVA: 65 dBA

2.03 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to ANSI C57.12.01 and IEEE C57.12.91.

2.04 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. Ratio tests at the rated voltage connection and at all tap connections
2. Polarity and phase relation tests on the rated voltage connection
3. Applied potential tests
4. Induced potential test
5. No-load and excitation current at rated voltage on the rated voltage connection

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Floor mounted transformers shall be mounted on a 3-1/2 inch concrete housekeeping pad 2 inches larger all around transformer.

C. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

D. Use flexible conduit under the provisions of Division 26 Section “Raceways and Boxes for Electrical Systems” for connections to transformer case. Minimum flexible conduit length shall be two (2) feet.

E. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

F. CONNECTIONS

1. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

2. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 IDENTIFICATION

A. Nameplates: Label each transformer with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems." Nameplates shall be engraved with the following information:

1. Transformer name

2. Fed from (primary source)

3. Secondary voltage, phase, wires

B. Warning Labels: Label each panelboard with a warning label indicating NFPA 70 workspace clearance requirements, complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Testing: Perform the field quality-control tests and inspections listed in this section.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage

minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Service and distribution switchboards rated 600 V and less.

B. Surge Protection Devices.

C. Disconnecting and overcurrent protective devices.

D. Accessory components and features.

1.02 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

C. SPD: Surge Protection Device

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies”

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of switchboard, switching and overcurrent protective device, instrumentation, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, weights, and finishes.

C. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

a) Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types for types other than NEMA 250, Type 1.

3. Include outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.

4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.

5. Detail short-circuit current rating of switchboard assembly and overcurrent protective devices.

6. Include descriptive documentation of barriers specified for electrical insulation and isolation.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

8. Include schematic and wiring diagrams for power, signal, and control wiring.

9. Include nameplate legends.

10. Include list of materials.

D. Qualification Data: For qualified Installer and testing agency.

E. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E; Employs installers and supervisors who are trained and approved by manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

D. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.06 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not install switchboards until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above secondary unit substation. Provide temporary HVAC system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a) Ambient Temperature: Not exceeding 104 deg F (40 deg C).

b) Altitude: Not exceeding 6600 feet (2000 m).

3. Service Conditions: NEMA PB 2, usual service conditions, as follows:

a) Ambient temperatures within limits specified.

b) Altitude not exceeding 6600 feet (2000 m).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

C. Coordinate delivery of equipment to allow movement into designated space.

D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

E. Handle and prepare switchboard components according to NEMA PB 2.1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.08 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the switchboards that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Refer to Division 26 section “Fuses” for spare fuse requirements. At a minimum, include spares for the following:

a) Fuses for fusible devices.

b) Potential transformer fuses.

c) Control power fuses.

2. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

2.02 RATINGS

A. Nominal System Voltage: As indicated on the Drawings.

B. Main-Bus Continuous: As indicated on the Drawings.

C. Short-Circuit Current Rating (SCCR):

1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section “Power System Studies”.
2. Rating value: Rated to interrupt symmetrical short-circuit current available at terminals. Switchboard shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in switchboard.

2.03 FABRICATION

A. Indoor Enclosures: Steel, NEMA 250, Type 1.

1. Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

B. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

C. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Bus bars shall connect between vertical sections and between compartments. Cable connections are not permitted.
2. Phase, and Neutral Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
3. Main-Phase Bus Size: Ampacity as indicated on drawings, with uniform capacity for entire length of switchboard's main and distribution sections.

4. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.

5. Vertical Section Bus Size: Ampacity equivalent to horizontal bus, with uniform capacity for entire length of vertical section bus.

6. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size required by UL 891.

7. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.

8. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.

D. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

E. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

F. Service Entrance Equipment:

1. Label: Where used as service entrance equipment, provide NRTL label for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

2.04 SURGE PROTECTION DEVICES

A. Provide surge protective devices as required by Division 26 Section “Surge Protective Devices”.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Ratings:

1. Continuous ampere rating: as indicated on drawings.

2. Voltage and frequency rating: same as switchboard.

3. Short-circuit current rating (SCCR): Same as requirements for switchboard.

4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Switchboards shall be fully-rated, unless series-rated is indicated on the drawings.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a) Standard frame sizes, trip ratings, and number of poles.

   b) Lugs: Mechanical style unless indicated otherwise on the Drawings, suitable for number, size, trip ratings, and conductor material.

   c) Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

C. Arc Flash Mitigation

1. Circuit breakers, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.

2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.06 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.07 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine switchboards before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive switchboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.

2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and manufacturer's instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Equipment Mounting: Install switchboards on concrete bases.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchboard unless otherwise indicated . Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

2. Anchor switchboards to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" ."

3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Install anchor bolts to elevations required for proper attachment to switchboards.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

E. Mount equipment plumb and rigid without distortion of enclosure.

F. Install overcurrent protective devices, surge suppression devices and instrumentation.

G. Install filler plates in unused spaces of panel-mounted sections.

H. Arrange conductors in auxiliary compartments and gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.04 IDENTIFICATION

A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.

B. Device Nameplates: Label each main, feeder and branch circuit device with a nameplate.

C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

D. Diagram and Instructions:

1. Frame and mount under clear acrylic plastic. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. . Mount on front of switchboard.

    a) Operating Instructions: Printed operating instructions for switchboard, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

2. Storage for Maintenance Instructions: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

E. Warning Labels: Label each switchboard with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Provide Arc Flash and available fault current warning labels.

3.05 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.07 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.08 FIELD QUALITY CONTROL

A. Testing: Perform the field tests and inspections listed below :

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS . Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

B. Video record demonstrations presentation for Owner’s records.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Distribution panelboards.

B. Lighting and appliance branch-circuit panelboards.

C. Disconnecting and Overcurrent Protective Devices.

D. Fused Lighting and Appliance Branch-Circuit Panelboards.

E. Surge Protection Devices.

F. Accessory Components and Features.

1.02 DEFINITIONS

A. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

B. SVR: Suppressed voltage rating.

C. SPD: Transient voltage surge suppressor.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies.”

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of panelboard, switching and overcurrent protective device, furnished accessories and components. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

a) Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Include general arrangement drawing showing dimensions and weights of each assembled section.

4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.

5. Detail short-circuit current rating of panelboard assembly and overcurrent protective devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include evidence of NRTL listing for series rating of installed devices.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.

9. Include schematic and wiring diagrams for power, signal, and control wiring.

10. Include nameplate legends.

11. Include list of materials.

D. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.

E. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Sample Warranty: For warranty.

G. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

H. Panelboard Schedules: Submit final panelboard directories.

I. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for panelboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

4. Video recording of operation training and demonstration.

1.05 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a) Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).

b) Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of equipment to allow movement into designated space.

B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

C. Handle and prepare panelboards for installation according to NEMA PB 1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.08 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the panelboards that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).

2. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Enclosures: Flush- or surface-mounted cabinets as noted.

1. Rated for environmental conditions at installed location.
    a) Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b) Outdoor Locations: NEMA 250, Type 3R.
    c) Kitchen and/or Wash-Down Areas: NEMA 250, Type 4X.
    d) Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
2. Door: Standard door with concealed hinges. Secured with vault-type latch with tumbler lock; keyed alike.
3. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
4. Finishes:
    a) Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b) Back Boxes: Galvanized steel .
5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and/or bottom as required.

D. Buses: Three phase, four wire unless otherwise indicated.

1. Phase, and Neutral Buses:
    a) Material:Tin-plated aluminum.
    b) Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard’s sections.
        1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. Ground lugs shall be dual rated for both aluminum and copper conductors. For busway feeders, extend insulated equipment

grounding cable to busway ground connection and support cable at intervals in vertical run.

a) Material: Hard-drawn copper, 98 percent conductivity or Tin-plated aluminum

b) Size: Minimum-size required by UL 67.

3. Provide any available breaker mounting space with bussing.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Dual rated for both aluminum and copper conductors.

2. Capacity rating: Same as associated bus.

F. Line-Side Conductor Connectors (Lugs):

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

2. Material: Same as bus material.

3. Capacity rating: Same as associated bus.

4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.

5. Provide properly sized lugs for all equipment, circuit breakers and other electrical devices to accommodate installed conductors. A larger frame, oversized lugs or non-standard product may be required in some instances.

a) Pin adapters may be utilized only as allowed by manufacturer and the authority having jurisdiction.

G. Feed-Through Lugs:

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

2. Location: Locate at opposite end of bus from line side lugs or main device.

3. Material: Same as line side conductor connectors.

4. Capacity rating: Same as associated bus.

5. Type: Same as line side conductor connectors.

H. Subfeed (Double Lugs):

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

2. Location: Locate at same end of bus as incoming lugs or main device.

3. Material: Same as line side conductor connectors.

4. Capacity rating: Same as associated bus.

5. Type: Same as line side conductor connectors.

I. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

J. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

K. Panelboard Short-Circuit Current Rating (SCCR):

1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section "Power System Studies".

2. Rating Value: Rated to withstand symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in panelboard.

2.02 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

C. Mains: As indicated on drawings.

D. Branch Overcurrent Protective Devices:

1. Connection to bus:

a) For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

b) For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2. Type: Provide types as indicated on drawings and as defined below.

E. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.

2. Voltage and frequency rating: same as panelboard.

3. Short-circuit current rating (SCCR): Same as requirements for panelboard.

4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: As indicated on drawings.

C. Branch Overcurrent Protective Devices:

1. Connection to bus: Plug-in circuit breakers, replaceable without disturbing adjacent units.

2. Type: Provide types as indicated on drawings and as defined below.

D. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.

2. Voltage and frequency rating: same as panelboard.

3. Short-circuit current rating (SCCR): Same as requirements for panelboard.

4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a) Standard frame sizes, trip ratings, and number of poles.

b) Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.

c) Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.05 FUSED LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS(1 TO 400A MAINS)

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable products by one of the following, the first listed manufacturer was used as the basis of design:

1. Eaton/Bussman Quik Spec Coordination Panelboards type QSCP
2. Mersen

B. Bus Bars: Shall be copper or tin-plated copper.

C. Panelboards: listed to UL 67

1. Provide space behind locking door for a minimum of 6 spaces to store replacement branch circuit fuses.

D. Mains:

1. Permanently installed lockout means shall be provided.
2. Quick-make, quick-break type.

E. Branch Overcurrent Protective Devices:

1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings
2. Device shall provide open fuse indication via permanently installed neon or LED indicating light.
3. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
4. No special tools shall be required for fuse removal.
5. Devices shall have bolt-on style bus connectors.
6. Device housing shall be clearly marked with device amperage.
7. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
8. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.
9. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 200kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J or CC performance characteristics.

2.06 SURGE PROTECTION DEVICES

A. Provide surge protective devices as required by Division 26 Section “Surge Protective Devices”.

B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.07 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.08 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive panelboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1 and manufacturer's instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Mount top of trim 72 inches (1788 mm) above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

1. Empty conduits shall be provided with pull strings.

2. Cap and label empty conduits for future use.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

K. Comply with NECA 1.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.04 IDENTIFICATION

A. Equipment Nameplates: Label each contiguous main, or entrance section with equipment nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

D. Diagram and Instructions:

1. Frame and mount under clear acrylic plastic. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of panelboard.

a) Operating Instructions: Printed operating instructions for panelboard, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.

F. Identify field-installed conductors, interconnecting wiring, and components; complying with Division 26 Section "Identification for Electrical Systems."

G. Panel Directories

1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

2. Noted the date the directory was created/updated.

3. Create directory after loads have been balanced to reflect actual as-built conditions.

4. Circuit descriptions shall be per code and shall be distinguishable from all others.

3.05 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.07 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Power System Studies."

3.08 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.

2. Verify that grounding system at the equipment tested at the specified value or less.

3. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.

4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.

2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective

devices, instrumentation, and accessories[, and to use and reprogram microprocessor-based trip, monitoring, and communication units].

B. Video record demonstrations presentation for Owner's records.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Receptacles:

1. Convenience including single, duplex, automatically controlled, and isolated ground.
2. Ground fault current interrupter type (GFCI).
3. USB charging devices
4. Twist-locking type receptacles.
5. Surge protective device (SPD).
6. Special purpose/miscellaneous devices.

B. Wall Switches

C. Wall Plates and Covers

D. Emergency Power Off Buttons

E. Remote Ground Fault Circuit Interrupter (GFCI) Devices

1.02 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. IG: Isolated Ground

C. PIR: Passive Infrared.

D. RFI: Radio Frequency Interference

E. SPD: Surge Protective Device

F. TR: Tamper Resistant

G. USB: Universal Serial Bus

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed. This shall apply to equipment furnished under this contract and equipment furnished by Owner or under separate contract.

3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.

4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.

5. Notify Contract Administrator of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".

B. Product data:

1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, cover plates, power poles, and multi-outlet assemblies.

C. Operations and Maintenance Data

1. Provide re-ordering instructions and directions for replacement surge modules for SPD receptacles.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.

B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.

2. Marked for intended use.

D. Comply with NFPA 70.

1.06 SPARES

A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. SPD Receptacles With Replacement Surge Modules: [One for every 10] of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.01 GENERAL

A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

B. Wiring Device Finishes:

1. Provide wiring device finishes as described below, unless otherwise indicated.
2. Wiring devices connected to normal power systems: Gray. Cover plates: stainless steel.
3. Wiring devices connected to emergency power systems: Red. Cover plates: stainless steel and engraved with "EMERGENCY POWER" with black filler in the engraving. Engrave the panelboard designation and circuit number serving the emergency device into the cover plate.
4. Hospital grade receptacles: As specified above, with a green dot on its face.
5. SPD devices: Blue. Cover plates: stainless steel.
6. Isolated-Ground receptacles: Orange, with an orange trangle on its face. Cover plates: stainless steel.
7. Material for cover plates in unfinished spaces and for surface mounted wiring devices: Galvanized steel.

2.02 RECEPTACLES:

A. Available Manufacturers:

1. Eaton
2. Hubbell Incorporated
3. Legrand
4. Leviton

B. Receptacles - General Requirements: Self-grounding, impact-resistant nylon face, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiringand screw actuated binding clamp for back wiring with separate ground terminal screw.

2. NEMA configurations specified are according to NEMA WD 6.

C. The basis-of-design catalog numbers listed below are generally for 20A rated duplex devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A. Where simplex devices are indicated on the drawings, provide similar, but simplex receptacle.

D. Convenience Receptacle:

Type - Duplex Convenience Receptacle	**Heavy Duty Specification Grade**	**Commercial Specification Grade**	**Specification grade, rectangular decorator style**	**Hospital Grade**	**Hospital Grade, Rectangular Decorator Style**
Standard Duplex	Legrand 5362	Legrand CR20 or CRB5362	Legrand 26352	Legrand 8300H	Legrand 26362HG
Automatically Controlled (Dual-controlled)	Legrand 5362CD	Legrand 5362CD	Legrand 26352CD		
Automatically Controlled (Half-controlled)	Legrand 5362CH	Legrand 5362CH	Legrand 26352CH		
Tamper-Resistant	Legrand TR5362	Legrand TR220 or TR5352	Legrand TR26342 or TR26352	Legrand TR8300H	Legrand TR26362HG
Tamper-Resistant Automatically Controlled (Dual-controlled)	Legrand TR5362CD	Legrand TR5362CD			
Tamper-Resistant Automatically Controlled (Half-controlled)	Legrand TR5362CH	Legrand TR5362CH			
Weather-Resistant	Legrand WR5362	Legrand WR20TR			

Weather-Resistant/Tamper-Resistant		Legrand WR20TR			
Isolated Ground		Legrand IG5362	Legrand IG26362	Legrand IG8300	Legrand IG26362HG

E. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

   a) Provide test and reset buttons of same color as device.

Type - Duplex GFCI	Specification Grade	Hospital Grade
Standard GFCI	Legrand 2097	Legrand 2097HG
Tamper-Resistant GFCI	Legrand 2097TR	Legrand 2097HGTR
Weather-Resistant GFCI	Legrand 2097TRWR	Legrand 2097HGTRWR
Weather-Resistant/Tamper-Resistant GFCI	Legrand 2097TRWR	Legrand 2097HGTRWR
GFCI with Isolated Ground	Legrand 2097IG	Legrand 2097IGHG
Blank Face	Legrand 2087	

F. USB Charging Devices:

1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.

   a) Charging Capacity - Two-Port Devices: 3.1 A, minimum.

   b) Charging Capacity - Four-Port Devices: 4.2 A, minimum.

   c) For GFCI Devices, see GFCI paragraph above for additional requirements.

Type - USB	Specification Grade	Hospital Grade
USB A/A with Standard Duplex	Legrand TR5362USB	Legrand TR8300HUSB
USB A/C with Standard Duplex	Legrand TR20USBAC	Legrand TR20HUSBAC
USB C/C with Standard Duplex	Legrand TR20USBCC	Legrand TR20HUSBCC
USB only 4-Port	Legrand TM8USB4	
USB A/A with Tamper-Resistant Duplex	Legrand TR5362USB	Legrand TR8300HUSB
USB A/C With Tamper-Resistant Duplex	Legrand TR20USBAC	Legrand TR20HUSBAC

USB C/C with Tamper-Resistant Duplex	Legrand TR20USBCC	Legrand TR20HUSBCC
USB C/C with TR/WR GFCI Duplex	Legrand 2097TRWRUSBCC	
USB A/C with GFCI Duplex	Leviton GUAC2	
USB A/A with GFCI Duplex	Leviton GUSB2	

G. Twist-Locking Type Receptacles:

1. The basis-of-design catalog numbers listed below are generally for 20A rated simplex devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A. Where duplex devices are indicated on the drawings, provide similar, but duplex receptacle.

Type - Twist Locking	
Standard Simplex	Legrand L520R
Isolated Ground Simplex	Legrand IGL52R

H. SPD Receptacles:

1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.
   a) Energy Dissipation: Not less than 240 J per mode.
   b) Protected Modes: L-N, L-G, N-G.
   c) UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
   d) Diagnostics:
      1) Visual Notification: Provide indicator light to report functional status of surge protection.
      2) Audible Notification: Provide switchable audible alarm to report that surge protection is not functional.
   e) Special Warranty: Manufacturer agrees to repair or replace SPD receptacles, or replaceable surge modules (if removable), that fail in materials or workmanship within 5 years from date of Substantial Completion.

Type - SPD	**Specification grade, rectangular decorator style**	**Hospital grade, rectangular decorator style**
SPD Duplex	Legrand 5362SP	Legrand 8300SP
Tamper-Resistant SPD Duplex	Legrand TR5362SP	

Isolated Ground Duplex	Legrand IG5362SP	IG8300SP

I. Special/Miscellaneous Devices:

1. Special purpose receptacles: Grounding type, UL listed with NEMA configurations as indicated below or on the Drawings.

Purpose	NEMA Configuration	
Dryer	14-30R	Legrand 3864
Range	14-50R	Legrand 3894
Switch/Receptacle Combo	5-20R	Legrand 671TRI
Clock	5-15R	Legrand S3733

2.03 SWITCHES

A. Available Manufacturers:

1. Eaton
2. Hubbell Incorporated
3. Legrand
4. Leviton

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring with separate ground terminal screw.

C. The basis-of-design catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.

D. Standard Wall Switches:

Type - Switches	Heavy Duty Specification Grade	Commercial Specification Grade
1-Pole	Legrand PS20AC1	Legrand CS20AC1 or CSB20AC1
2-Pole	Legrand PS20AC2	Legrand CSB20AC2
3-Way	Legrand PS20AC3	Legrand CS20AC3 or CSB20AC3
4-Way	Legrand PS20AC4	Legrand CSB20AC4

E. Key operated light switches: Same as standard light switches except toggle handle shall be operated by a factory provided key.

2.04 WALL PLATES AND COVERS

A. Wall Plates: Comply with UL 514D.

1. Match corresponding wiring devices and manufacturer of wiring devices specified herein.
2. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
3. Size: Standardunless otherwise indicated..
4. Screws: Metal with slotted heads finished to match wall plate finish.

B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

D. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

E. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover for horizontal mounting and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type. (Covers listed are single-gang for GFCI device, 2-gang or other device similar.) Back box must be suitable for conduit connections. Coordinate back box with wall depth.

Weatherproof cover for Wet Location In-Use	Cast Aluminum	High Impact Polycarbonate
Horizontal	Hubbell WP26EH	Hubbell RW58300
Vertical	Hubbell WP26E	Hubbell RW58300

2.05 EMERGENCY POWER OFF BUTTONS

A. Available Manufacturers:

1. ABB
2. Eaton
3. Schneider Electric

B. Push Button Operators: 30MM, watertight/oil tight, heavy duty, 600V maximum ac/dc, 10A continuous, momentary, non-illuminated, shrouded push button operator. Provide with 1 normally open and 1 normally closed contact block.

1. Basis of Design: Schneider Electric 9001KR1RH13

C. Push/Pull Button Operators: 30MM, watertight/oil tight, heavy duty, 600V maximum ac/dc, 10A continuous, 2 position maintained, non-illuminated, push/pull button operator. Provide with 1 normally open and 1 normally closed contact block.

1. Basis of Design: Schneider Electric 9001SKR9RH13

D. Break Glass Operators: 30MM, watertight/oil tight heavy duty, 600V maximum ac/dc, 10A continuous, push button operator that when disk is broken the operator is released to its open position. Provide with 1 normally closed contact block, surface or recess mounted, NEMA 1, 4, 4X enclosure with integral break glass hammer and chain.

1. Basis of Design: Schneider Electric 9001K15

2.06 REMOTE GROUND FAULT CIRCUIT INTERRUPTER (GFCI) DEVICES

A. Available Manufacturers:

1. Hubbell
2. Littlefuse
3. North Shore Safety

B. UL 943 Class A Ground Fault Circuit Interrupter (GFCI) device in NEMA 4X wet location enclosure, voltage, phase, and current rating as shown on drawings. UL 943. Device shall have power and fault status indication lights and manual test and reset buttons on exterior of enclosure. Device shall allow for reset as follows:

1. Automatic reset: Allows power downstream as long as power is available and will allow power downstream upon restoration of lost power. Requires reset button be pressed if unit trips due to fault condition.

PART 3 - EXECUTION

3.01 GENERAL

A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Contract Administrator.

B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.

C. Provide twist-locking type receptacles or other special type receptacles where indicated on the Drawings.

3.02 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.03 PREPARATION

A. If required, provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.04 INSTALLATION

A. Install in accordance with manuacturer's instructions.

B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.

C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.

E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.

F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.

G. Install switches with OFF position down.

H. Install cover plates on all switches, receptacles, and blank outlets.

I. Locate wiring devices so that the cover plate does not have to be cut to be installed.

J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

K. Install cover plates after the wall has been finished (painted, wall paper, etc).

L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

M. Provide engraved nameplate on emergency off buttons.

N. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6' or sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.

O. Provide type and quantity of normally open and/or normally closed contacts for emergency off buttons to meet the sequence of operations shown.

P. Install wiring devices shown back-to-back on a common wall offset a minimum of 12" horizontally to reduce sound transmission between rooms.

3.05 MOUNTING HEIGHTS AND ORIENTATION

A. Coordinate locations of outlet boxes provided under Division 26 Section "Common Work Results for Electrical".

B. Unless otherwise noted, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.

1. Receptacles:

a) General:

1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.

2) Where Installed horizontally, install neutral slot mounted at the top.

b) Above counters:

1) Mount horizontally

c) Mechanical and electrical equipment rooms and janitors closets: mount horizontally.

d) Garages:

1) Wet location: Mount horizontally.

2) Other locations: Mount horizontally.

e) Weatherproof exterior receptacles: mount horizontally.

f) GFCI receptacles: Same as general receptacles.

g) Isolated ground receptacles: Same as general receptacles.

h) SPD receptacles: Same as general.

i) Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.

C. Switches:

1. Above counters: Same as for receptacles.

2. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.

a) Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.

D. Multi-outlet assemblies (unless otherwise indicated on the Drawings):

1. 36 inches above finished floor.

E. Telephone/Data Outlet Boxes:

1. General: Match mounting height of adjacent wiring device listed above.

F. Emergency Power Off Buttons and Break Glass Operators:

1. General: Match requirements of switches listed above.

3.06 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Emergency Power Off Buttons:

a) Provide engraved nameplate on emergency off buttons.

b) Identify equipment, device or system controlled by emergency power off button.

B. Automatically Controlled Convenience Receptacles: controlled receptacle marking on device face per NFPA 70.

C. Label all devices fed down stream of GFCI protected receptacles as “GFCI PROTECTED”.

3.07 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

D. Test all wiring devices for electrical continuity and proper polarity of connections.

E. Test each GFCI receptacle device for proper operation.

F. Correct wiring devices incorrectly installed.

G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.08 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.09 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Cartridge Fuses

B. Accessories

1. Fuseholders

C. Spare fuse cabinet

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.

2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed and with system short-circuit levels.

3. Coordinate location of and access to spare fuse cabinet(s) with final electrical equipment layouts within electrical equipment rooms.

4. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies.”

1.03 SUBMITTALS

A. Product Data: For each type of product indicated; include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets.

1. Include the following for each fuse type indicated:

a) Dimensions and manufacturer's technical data on features, perfor, electrical characteristics, and ratings.

b) Current-limitation curves for fuses with current-limiting characteristics.

c) Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

d) Coordination charts and tables and related data.

e) Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. All items requested under “Product Data”.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Comply with NEMA FU 1 for cartridge fuses.

E. Comply with requirements of NFPA 70.

F. Comply with UL 248.

1.05 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Selectivity: Where selectivity is required by the Documents, furnish products as required to achieve selective coordination.

2.02 MANUFACTURERS

A. Manufacturers:

1. Bussmann, a division of Eaton Corporation; www.cooperindustries.com.
2. Littelfuse, Inc;: www.littelfuse.com.
3. Mersen;: ep-us.mersen.com.
4. Edison Fuse, Inc; www.edisonfuses.net.

2.03 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.04 ACCESSORIES

A. Fuseholders: Compatible with indicated fuses.

2.05 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with [15] percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.

B. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolearances and other conditions affecting performance, such as rejection features.

C. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fuses in accordance with manufacturer's instructions.

B. Do not install fuses until circuits are ready to be energized.

C. Install fuses in fusible devices. Arrange fuses so manufacturer, type and rating information is readable without removing fuse.

D. Install spare fuse cabinet where indicated.

3.03 FUSE APPLICATIONS

A. Cartridge Fuses

1. Feeders:
    a) Greater than 600A:
        1) Class L, time delay
    b) 600A or less:
        1) Class RK1, time delay
2. Motor Branch Circuits:
    a) Class RK1, time delay
3. Other Branch Circuits:
    a) Class RK1, time delay
4. Control Circuits
    a) Class CC, fast acting

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fusible switches.

B. Non-fusible switches.

C. Enclosures.

1.02 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of enclosed switches, circuit breakers and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies”.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and Manufacturer’s technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.

C. Shop Drawings: For enclosed switches and circuit breakers.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

    a) Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for other than NEMA 250, Type 1.

3. Include general arrangement drawing showing dimensions and weights of each assembled section.

4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.

5. Detail short-circuit current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.

6. Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.

7. Include schematic and wiring diagrams for power, signal, and control wiring.

8. Include nameplate legends.

9. Include list of materials.

D. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.

E. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Sample Warranty: For warranty.

1. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

G. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches and circuit breakers that fail in materials or workmanship within the specified warranty period.

H. Warranty Period: Three years from date of Substantial Completion.

1.05 EXTRA MATERIALS

A. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Refer to Division 26 section “Fuses” for spare fuse requirements. At a minimum, include spares for the following:

a) Fuses for fusible devices.

b) Potential transformer fuses.

c) Control power fuses.

2. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).

3. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.07 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install enclosed switches and circuit breakers until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is

operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a) Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

b) Altitude: Not exceeding 6600 feet (2010 m).

C. Interruption of Existing Electric Service: Refer to Division 26 section “General Electrical Requirements."

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver enclosed switches and circuit breakers in sections or lengths that can be moved past obstructions in delivery path.

B. Coordinate delivery of equipment to allow movement into designated space.

C. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

D. Handle and prepare enclosed switches and circuit breakers components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac (Minimum rating shall meet voltage served), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Short Circuit Current Rating: 100,000 rms symmetrical amps when fuses applied.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Hook stick Handle: Allows use of a hook stick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

E. Arc Flash Mitigation

1. Fuses 1200 A and larger, shall have a clearing time of 0.07 seconds or less at the available arcing current, or shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.02 NONFUSIBLE SWITCHES

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac (Minimum rating shall meet voltage served), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hook stick Handle: Allows use of a hook stick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

C. Outdoor Locations: NEMA 250, Type 3R.

2.04 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine enclosed switches and circuit breakers before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive enclosed switches and circuit breakers with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install enclosed switches and circuit breakers and accessories in accordance with manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Wall-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches and circuit breakers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Mount equipment plumb and rigid without distortion of enclosure.

G. Install fuses in fusible devices.

H. Comply with NECA 1.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.04 IDENTIFICATION

A. Equipment Nameplates: Label each section with equipment nameplate.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

C. Diagrams and instructions:

1. Frame and mount under clear acrylic plastic. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of equipment.

a) Operating Instructions: Printed operating instructions for switches and circuit breakers, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

D. Warning Labels: Label equipment with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on enclosed switches and circuit breakers in finished spaces.

3.05 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.07 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges and protective relay trip characteristics as specified in Division 26 Section "Power System Studies."

3.08 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

4. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, instrumentation, and accessories[, and to use and reprogram microprocessor-based trip, monitoring, and communication units].

B. Video record demonstrations presentation for Owner’s records.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Static bypass transfer switch.
6. Battery and battery disconnect device.
7. Internal maintenance bypass/isolation switch.
8. Remote status and alarm panel
9. Remote UPS monitoring provisions.
10. Battery monitoring.
11. Remote monitoring.
12. Lithium Ion battery system specialty requirements.

1.02 DEFINITIONS

A. Bypass: Isolation of UPS system and continued load operation without power loss.

B. Double Conversion: Series online static UPS design, isolating loads by continuous AC/DC conversions.

C. Firmware: Embedded instructions within hardware devices, stored in nonvolatile memory, to control functions, update instructions, and enable communications.

D. Inverter: Converts DC to AC power.

E. Line Interactive: Parallel online static UPS design, monitoring incoming source, and supplementing power when required.

F. Power Module: Containerized UPS, modular in design and installed in UPS frames or cabinets.

G. Rectifier: Conversion of AC to DC power.

H. VRLA: (Valve-regulated lead-acid) Sealed cells with valve that compensates for internal compared to ambient pressure. Recombinant battery technology, retaining water and acid instead of venting to environment; lead acid.

I. LCD: Liquid-crystal display.

J. LED: Light-emitting diode.

K. THD: Total harmonic distortion.

L. UPS: Uninterruptible power supply.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's standard catalog pages and data sheets for equipment and protective devices, indicating information relevant to studies.

B. Shop Drawings: Submit dimensioned plan and elevation views of UPS system and power distribution, DC-Link, related equipment, and system components, with required clearances identified. Indicate locations of system components, attachment locations, and details of supports, fittings, building element penetrations, and equipment connections.

1. Include wiring diagrams showing factory and field connections with wire, overcurrent protective device arrangement, circuit breaker/fuse sizes, and circuiting arrangements. Include proposed connection method, size, type, and routing of conduits and cables.

2. Indicate outline and support point dimensions, unit arrangement and sizes, input/output voltages, bus ampacities, power ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

3. Include system interconnection schematic diagrams showing factory and field connections, and requirements for interface with other systems.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around UPS's where pipe and ducts are prohibited. Show transfer switch layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

2. Dimensioned concrete base, outline of UPS, and conduit entries; including equipment working clearances and manufacturer required access space.

3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.

4. Location of structural supports for structure-supported raceways.

5. Location and clearance of electrical equipment and raceways impacting equipment installation.

6. Proposed routing of equipment, in shipping splits, from exterior of the building to the final installed location. Include product weights, width and height restrictions encountered along the path. Include intended construction sequencing to mitigate conflicts.

7. Proposed routing of equipment for future removal, from within equipment room to exterior of the building without removal of non-related equipment or architectural elements.

D. Manufacturer Certificates: For each product, from manufacturer.

E. Factory Test Reports: Comply with specified requirements.

F. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

G. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

H. Manufacturer's field service report.

I. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.

1. Include detailed information on system operation, equipment programming, and setup, and replacement parts.

2. Include detailed information on status indicators, recommended maintenance procedures, and intervals.

3. Manufacturer's written instructions for testing central battery equipment.

4. Include contact information for entity providing contract maintenance and trouble call-back service.

J. Warranties: Sample warranties for each warranty type listed below.

K. Reports and Design Guide indicating requirements that must be met for the Lithium-ion battery cabinet to meet the unit level criteria listed in the UL9540A large scale fire test.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified with minimum 5 years of documented experience.

1. Authorized service facilities located within 250 miles of project site.

B. Installer Qualifications: Company specializing in performing work with minimum 5 years documented experience with similar UPS systems (e.g., similar size, type, and complexity).

1. Manufacturer's authorized installer.

2. Installer Personnel: Minimum 2 years of experience installing UPS systems.

C. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. UL Compliance: Listed and labeled under UL 1778 by an NRTL.

F. Comply with NFPA 70.

G. Comply with NFPA 111.

H. Comply with Fire Code for Energy Storage: ICC (IFC).

I. The Lithium-ion battery solution shall meet the requirements of the following standards:

1. Fire Safety: Must demonstrate that the UL9540A large scale fire test criteria are met at the unit level. The report shall be available upon request.

2. Safety: UL 1998, UL 991, UL 1973, UL 1642

3. EMC/EMI: EN 61000-6-2, EN 61000-6-4

1.05 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Between 64.4 degrees F (18 degrees C) and 82.4 degrees F (28 degrees C) for operation conditions. Betwen 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C) for storage conditions.

2. Relative Humidity: Between 0 and 95 percent, noncondensing.

3. Altitude:

a) Up to 3,300 feet (1000 m) with no derating.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to system components, enclosure, and finish.

D. Equipment Containing Batteries: Do not exceed three months of storage without powering for eight hours to recharge batteries.

1.07 WARRANTY

A. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for duration below. Complete forms in Owner's name and register with manufacturer.

1. UPS: Provide minimum standard warranty of 12 months from date of installation or acceptance by Owner, or 18 months from date of shipment, whichever occurs first.

2. Lithium Ion Batteries: Provide three year warranty from battery manufacturer.

1.08 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Cabinet Ventilation Filters: One complete set(s).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. The first listed manufacturer was used as the basis of design:

1. Schneider Electric

2. ABB.

3. Eaton Corporation Inc.

4. Mitsubishi Electric Automation, Inc.

5. Toshiba Power Electronics.

6. Vertiv Group Corp.

2.02 STATIC UPS SYSTEMS

A. The UPS shall be housed in a freestanding cabinet with casters. Maintenance shall be possible from the front.

B. Output power factor: 1.0.

C. Backfeed contactor included for input. Mandatory bypass backfeed protection must be implemented by:

1. Installation of upstream circuit breaker with shunt-trip connected to the UPS, or

2. Installation of optional breaker kit providing this functionality, or

3. Installation of manufacturer specific maintenance bypass cabinet.

D. The UPS shall support installation with either 3-wire (L1, L2, L3, PE) or

E. 4-wire (L1, L2, L3, N, PE). The supply for input and bypass must be solid-grounded WYE transformers. Delta input supply for either input or bypass is not permitted.

F. The UPS shall contain a static bypass switch and a display. The UPS shall be of the double conversion on-line topology with power factor corrected inputs.

1. The UPS shall be sized for kVA loads as indicated on the Drawings.

2. The UPS battery shall be sized for the runtime indicated on the Drawings.

G. The UPS shall have a minimum input short-circuit level of 65 kAIC.

H. The UPS shall be tested against EMC (electromagnetic compatibility) according to FCC part 15 Subpart B Class A.

I. System Input:

1. Nominal input voltage as indicated on the Drawings with input window of plus or minus 15%.

2. Input frequency of 60 Hz with window from 40-70 Hz.

3. Input power factor:

a) 0.99 at load >25%

b) 0.95 at load >15%

4. Total harmonic distortion: < 5%

J. System Output:

1. Nominal output voltage rating: As indicated on the Drawings, 3-phase.
2. Output voltage tolerance:
   a) +/- 1% for symmetrical loads.
   b) +/- 3% for asymmetrical loads.
3. Dynamic load response:
   a) +/- 5% after 2 ms
   b) +/- 1% after 50 ms
4. Output frequency: 50 or 60 Hz.
5. Output voltage harmonic distortion:
   a) <1% at 100% linear load
   b) <5% at 100% non-linear load
6. Overload capability:
   a) 150% for 1 minute (normal operation)
   b) 125% for 10 minutes (normal operation)
   c) 125% for 1 minute (battery operation)
   d) 125% continuous (bypass)
   e) 1000% for 60 ms (bypass)
7. Output power factor: 1.0
8. Audible noise at full load:
   a) 62 dBA at 70% load
   b) 65 dBA at 100% load
9. Systems directly supplying the primary side of transformers shall have output rating and overload capability required to accomodate transformer inrush currents during energization.

2.03 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.

3. Power Failure:

    a) If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.

    b) When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.

    c) If the battery becomes discharged and normal supply is available, the rectifier-charger must charge the battery. The rectifier-charger must automatically shift to float-charge mode on reaching full charge.

4. Requested Static Bypass:

    a) The UPS can be transferred to requested static bypass following a command from the display. During static bypass operation, the load is supplied from the bypass source. If a fault is detected, the UPS will transfer to normal operation or forced static bypass operation. If there is an interruption to the utility/mains power supply during requested static bypass operation, the system will transfer to battery operation.

5. Forced Static Bypass:

    a) The UPS is in forced static bypass following a command from the UPS system or because the user has pressed the inverter OFF button on the UPS. During forced static bypass operation, the load is supplied directly by the bypass source.

6. External Maintenance Bypass:

    a) When the maintenance bypass breaker (MBB) is closed in the external maintenance bypass panel/cabinet, the UPS transfers to external maintenance bypass operation. The load is supplied with unconditioned power from the bypass source. Service can be performed on the entire UPS during external maintenance bypass

7. UPS Failure or Fault Conditions:

    a) If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch must switch the load to the normal AC supply circuit without disturbance or interruption.

    b) If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.

1) When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.

c) If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.

2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.

2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS AC supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.

3. Normal: Normal UPS AC supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

2.04 PERFORMANCE REQUIREMENTS

A. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.

2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.

3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.

4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.

5. Load is 30 percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is as indicated on the Drawings.

C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 percent from nominal voltage.

D. Overall UPS Efficiency: Equal to or greater than 94 percent at 100 percent load, 94 percent at 75 percent load, and 94 percent at 50 percent load.

E. Maximum Energizing Inrush Current: Eight times the normal full-load current.

F. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

G. Programmable Walk-In current or time.

H. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Rectifier-charger circuits must limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.

J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current, with a load crest factor of 3.0.

K. Minimum Overload Capacity of UPS at Rated Voltage:

1. 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes

L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

M. Input Power Factor: A minimum of 0.95 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

N. Output Power Factor Rating: 1.0. Loads with power factor of 0.9 leading to 0.8 lagging must not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:

1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

O. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

2.05 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each AC power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolations switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested in accordance with IEEE C62.41.1 and IEEE C62.41.2, Category B.

2.06 RECTIFIER-CHARGER

A. The UPS shall include an active power factor correction rectifier.

B. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 80% of UPS output rating at <40% load or 20% of UPS output rating at 100% within 10 times the rated discharge time.

C. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

D. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

E. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

F. Input power factor shall be 0.98 lagging at 100% load without the use of passive filters. Rectifier shall employ electronic waveform control technology to maintain the current sinusoidal.

G. Pulse Width Modulation (PWM) current control shall be used. Digital Signal Processors (DSP) shall be used for all monitoring and control tasks. Analog control shall not be acceptable.

H. Nominal input voltage shall be as indicated on the Drawings.

2.07 INVERTER

A. Description: Pulse-width modulated using DSP logic.

B. The inverter modules shall be rated for an output power factor at 1.0.

C. Nominal output voltage shall be as indicated on the Drawings.

2.08 STATIC BYPASS TRANSFER SWITCH

A. Description: The static bypass switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Partly rated SCRs with a wraparound contactor shall not be acceptable.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

C. The static bypass switch shall automatically transfer the load to bypass supply without interruption after the logic senses conditions noted in Operational Requirements sections above:

2.09 BATTERY

A. Description: Lithium ion, lightweight compact units factory assembled in cabinets.

1. Arrange for battery cabinets to be front-access only for installation, service, and maintenance.

2. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet.

B. Battery Monitoring:

1. Battery monitoring shall be provided at system level.

2. The UPS shall incorporate a battery capacity test that will determine the available runtimes.

3. The Li-ion battery solution shall communicate with the UPS via dry contacts.

4. Battery monitoring shall be provided at the module, rack, and system level. Two switched-mode power supplies (SMPS) shall be included and shall provide power for the battery monitoring system. These SMPS shall be supplied by the Lithium-ion battery strings themselves.

a) The SMPS shall be 1+1 redundant design, so when any SMPS power supply unit is inoperable, it should give alarm signal to the UPS

2.10 ENCLOSURE

A. The UPS shall be housed in a freestanding cabinet with casters.

B. Dust filter shall be available in two versions for different dust protection capabilities.

C. The cable entry shall be from the top of the UPS. A bottom entry cabinet is available as an option.

D. The cabling section shall be large enough to accept copper, copper-clad aluminum, and aluminum cables.

E. The UPS shall have an ingress level of minimum IP20.

F. The UPS shall offer an option of using 2-hole lugs to prevent risk of lug rotation after cable connection.

G. Each battery cabinet shall feature a DC-rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet.

H. The cabinet shall have a second layer of cover plate for high voltage areas and battery modules for operator safety protection.

I. The cabinet shall be designed for natural air cooling

J. The Lithium-ion battery cabinet must meet the unit level criteria listed in the UL9540A large scale fire test.

2.11 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. A color touch screen display shall be located on the front of the UPS.

C. The following metered data shall be available on the display:

1. Year, month, day, hour, minute, second of occurring events.
2. Input voltage.
3. Input current.
4. Input frequency.
5. Output voltage.

6. Output current.
7. Output frequency.
8. Battery voltage.
9. Battery current.
10. Battery temperature.
11. Energy monitoring

D. The display shall allow the user to display active alarms.

E. The following controls or programming functions shall be accomplished by use of the display unit.

1. Silence audible alarm.Set the alphanumeric display language.Display and set the date and time.
2. Enable or disable the automatic restart feature.
3. Transfer load to and from static bypass.
4. Test battery condition on demand.

F. Alarms: The following alarms shall be available through the Web interface. The Web interface shall allow the Owner to display a log of active alarms. The following minimum set of alarm conditions shall be available:

G. Under temperature – Cell: Battery cell under temperature

1. Voltage imbalance – Cell: Battery cell voltage imbalance
2. Temperature imbalance: Battery cell temperature imbalance
3. Communication failure 1: Communication failure between module BMS and rack BMS
4. Communication failure 2: Communication failure between rack BMS and system BMS
5. Communication failure 3: Communication failure between system BMS and UI
6. Voltage sensing error: Rack voltage sending error
7. Current sensing error: Rack current sensor failure
8. Fuse failure: Rack fuse failure
9. SW failure MCCB: Rack MCCB failure
10. SW sensor failure MCCB: Rack MCCB failure (sensor)
11. LEDs for indication of operation mode.

H. Push button user controls:

1. Inverter ON.

2. Inverter OFF.

I. For purposes of remote communications with the UPS, a network management card shall be integrated.

J. The Lithium-Ion battery system shall be monitored at all times at the module, rack, and system level. Three different Building Management System (BMS)

1. **Module BMS:** Cell Voltage and Temperature Measurement, Communication to Rack BMS
2. Rack BMS: Rack Voltage and Current Measure, SOC and SOH Calculation, Protection Control
3. **System BMS**: Consolidation at system level and Communication

K. Main Protections:

1. Overvoltage: Cell voltage ≥ 4.28V, 5 sec
2. Undervoltage: Cell voltage <=2.5V, 5 sec
3. Overcurrent 1: >=470A 60 sec
4. Overcurrent 2: >=495A 30 sec
5. Overcurrent 3: >=540A 10 sec
6. Overcurrent 4: >=600A 1 sec
7. Voltage – Imb: Max cell ≥ 3.8V & Cell △>= 100mV, 5 sec
8. Temp – Imb: Max cell T – Min cell T ≥ 104°F, 30 sec
9. Fuse Failure: Fuse blown

2.12 CONTROLS AND MONITORING ACCESSIBILITY

A. Software and connectivity:

1. The Ethernet Web/SNMP Adaptor shall allow one or more network manage- ment systems (NMS) to monitor and manage the UPS in TCP/IP network envi- ronments. The management information base (MIB) shall be provided in MIB formats. The SNMP interface adaptor shall be connected to the UPS via the RJ45 serial port on the standard communication interface board.
2. The UPS shall offer a Modbus interface.
3. The UPS shall be equipped with eight dry contacts (four inputs, four outputs) for user-assignable alarms or remote monitoring.

B. Remote UPS monitoring

1. At least one method of remote UPS monitoring shall be available.

C. Software compatibility

1. The UPS manufacturer shall have available software to support shutdown and or remote monitoring for the following systems.

D. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.13 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use simulated battery testing. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

3.02 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.04 IDENTIFICATION

A. Identify components and wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify each battery cell individually.

3.05 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Comply with manufacturer's written instructions.
2. Inspect interiors of enclosures, including the following:
3. Integrity of mechanical and electrical connections.
4. Component type and labeling verification.
5. Ratings of installed components.
6. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
7. Test manual and automatic operational features and system protective and alarm functions.
8. Test communication of status and alarms to remote monitoring equipment.
9. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.

10. Simulate malfunctions to verify protective device operation.

11. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.

12. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.

13. Test output voltage under specified transient-load conditions.

14. Test efficiency at 50, 75, and 100 percent of rated loads.

15. Test remote status and alarm panel functions.

16. Test battery-monitoring system functions.

D. The UPS system will be considered defective if it does not pass tests and inspections.

E. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

F. Prepare test and inspection reports.

3.07 PERFORMANCE TESTING

A. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period .

1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.

2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

B. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

1. Current: Each phase and neutral and grounding conductors.

2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.

3. Frequency transients.

4. Voltage swells and sags.

5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.

C. Monitoring and Testing Procedures for Each Test Period:

1. Exploratory Period: For the first two days of the first scheduled monitoring and testing period, make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.
2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
3. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
4. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
5. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
6. Using loads and devices available as part of the facility's installed systems and equipment, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
7. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.

D. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.

1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.

2. Coordinate printouts with recordings for monitoring performed according to this article, and resolve and report any anomalies in and discrepancies between the two sets of records.

E. Monitoring and Testing Assistance by Contractor:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.

2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.

3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.

4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.

5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

F. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

G. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in each report:

1. Description of corrective actions performed during monitoring and survey work and their results.

2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.

3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.

4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.

5. Recommendations for operating, adjusting, or revising UPS controls.

6. Recommendation for alterations to the UPS installation.

7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.

8. Recommendations for power distribution system revisions.

9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

H. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Bypass/isolation switches.
3. Nonautomatic transfer switches.
4. Remote annunciation systems.
5. Remote annunciation and control systems.

B. This section does not include the following:

1. Double throw (manual type) switches. Refer to Division 26 section "Enclosed Switches and Circuit Breakers" for this equipment.

1.02 DEFINITIONS

A. Closed Transition (Make–Before–Break): In a switching device, a configuration in which the new connection path is established before the previous contacts are opened. This prevents the switched path from ever seeing an open circuit.

B. Open Transition (Break-Before-Make): A switch that is configured to break (open) the first set of contacts before engaging (closing) the new contacts. This prevents the momentary connection of the old and new circuit paths together.

C. Withstand duration: The withstand rating value is the level of fault current that must be withstood for a specified length of time, i.e., 42000 amps at 3 cycles.

D. Level 1 Equipment: Level 1 is the more stringent NFPA emergency life safety requirement and is imposed when failure of the emergency system, including the transfer equipment could result in loss of human life or serious injury.

E. Level 2 Equipment: Level 2 is the less stringent NFPA emergency life safety requirement and is imposed when failure of the emergency system including the transfer equipment is less critical to human life safety.

F. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of electrical equipment with other construction that penetrates walls or is supported by them, including electrical and other types

of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study"

1.04 SUBMITTALS

A. Product Data: For each type of transfer switch, switching and overcurrent protective device, instrumentation, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each transfer switch and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

    a) Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for other than NEMA 250, Type 1.

3. Include general arrangement drawing showing dimensions and weights of each assembled section.

4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

5. Detail short-circuit current rating of transfer switch assembly and overcurrent protective devices.

6. Include descriptive documentation of barriers specified for electrical insulation and isolation.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in transfer switch; include

selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.

9. Include schematic and wiring diagrams for power, signal, and control wiring.

10. Include nameplate legends.

11. Include list of materials.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around transfer switches where pipe and ducts are prohibited. Show transfer switch layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

2. Dimensioned concrete base, outline of transfer switch, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.

3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.

4. Location of structural supports for structure-supported raceways.

5. Location and clearance of electrical equipment and raceways impacting equipment installation.

6. Proposed routing of equipment, in shipping splits, from exterior of the building to the final installed location. Include product weights, width and height restrictions encountered along the path. Include intended construction sequencing to mitigate conflicts.

7. Proposed routing of equipment for future removal, from within equipment room to exterior of the building without removal of non-related equipment or architectural elements.

D. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.

E. Qualification Data: For qualified manufacturer and testing agency.

F. Factory test reports.

G. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

H. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

I. Manufacturer's field service report.

J. Sample Warranty: For warranties.

K. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

L. Operation and Maintenance Data: For transfer switches to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for transfer switches and all installed components.

2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

3. Time-current curves; include selectable ranges for each type of overcurrent protective device. Provide relay-settings and calibration instructions, including software, where applicable.

4. Features and operating sequences, both automatic and manual.

5. Video recording of operation training and demonstration.

M. Follow-up service reports.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer. The manufacturer furnishing the generator shall be the same supplier of the transfer switch. The transfer switch circuit breaker (if

present) shall be coordinated with the generator circuit breaker to provide coordinated tripping.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NEMA ICS 1.

G. Comply with NFPA 70.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.06 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install transfer switches until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a) Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C) .

b) Altitude: Not exceeding 6600 feet.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

B. Deliver transfer switches in sections or lengths that can be moved past obstructions in delivery path.

C. Coordinate delivery of equipment to allow movement into designated space.

D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy

canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

E. Handle and prepare transfer switch components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.08 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of the Transfer Switch that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a) Damage from transient voltage surges.

B. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

C. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Indicating Lights: Four of each type installed.
2. Switching Contact Lubricant: One container.
3. Alarm Contacts: Equal to 10 percent of quantity supplied, but no fewer than two of each type.
4. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).
5. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturers:

1. Contactor Transfer Switches:

a) Caterpillar; Engine Div.

b) Eaton Electrical Inc.; Cutler-Hammer

c) Emerson; ASCO Power Technologies, LP.

d) GE Zenith Controls.

e) Kohler Power Systems; Generator Division.

f) Onan/Cummins Power Generation; Industrial Business Group.

g) Russelectric, Inc.

h) Spectrum Detroit Diesel.

B. Indicated Voltage and Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated. Voltage ratings shall be consistent with applications from 115 volts AC to 600 volts and single or three phase as required by the application. Current ratings and the number of poles shall be as indicated on the plans.

C. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

2. Where the transfer switch internal fault-current protection can not exceed the indicated fault-current values, an enclosed fused switch with current limiting fuses shall be installed ahead of the transfer switch.

D. Controls: Solid State control having repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C. All internal controls components shall be accessible from the equipment front.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Terminal: Solid and fully rated bus bar, unless otherwise indicated.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. All factory wiring shall be accessible from the equipment front. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated. Power terminals shall be rated for 90 degree C and copper or aluminum cable.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

K. Bus and Wiring: All Bus and cable /control wire shall be copper.

L. Cable Entry: Cable entry shall be from the top.

2.02 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Automatic open-transition transfer switches: Include the following functions and characteristics:

1. Fully automatic break-before-make.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Frequency: Monitor the frequency of the incoming normal power circuit. For the normal source, initiate transfer if the frequency varies more that 5% from the rated nominal value. For the emergency source, inhibit transfer if the normal source circuit frequency varies more that 5% from the rated nominal value.

4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

6. Test Switch: Simulate normal-source failure.

7. Switch-Position Pilot Lights: Indicate source to which load is connected.

8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

   a) Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

   b) Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

9. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

10. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum. Engine starting contact shall remotely start the generator immediately upon initiation by the normal source monitor.

12. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a) Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

    b) Push-button programming control with digital display of settings.

    c) Integral battery operation of time switch when normal control power is not available.

14. Elevator Application: Provide the following functions if automatic transfer is for elevator control:

    a) Auxiliary contact closure upon the transfer to the alternate source to signal the elevator controller(s) for emergency operation.

    b) Auxiliary contact closure, adjustable from 0 to 20 seconds before retransfer to normal source to allow for elevator motor-generator sets to disconnect from the power source.

    c) Auxiliary contact closure, adjustable from 0 to 20 seconds before testing transfer operation to signal the elevator controller(s) for emergency operation.

2.03 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Bypass/Isolation switch shall have main contacts and operating mechanism similar to the Automatic Transfer Switch except all operations shall be manual. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.

2. Bypass/Isolation Switch Configuration, Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

3. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.

4. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less. Operation of the bypass/isolation switch shall be allowed regardless of the position of the automatic transfer switch. Switch operation shall provide for positive and complete sequencing of all contact motion and shall prevent any form of intermediate stop or delayed motion.

5. Engine Run Circuit Interface: There shall be sufficient controls included to assure that the engine run circuit remains closed when the switch is in the bypass-to-emergency position even though the associated transfer switch is in the normal position or completely removed from the enclosure.

6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.

7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors. If the unit is constructed such that removal of components is not allowed, then the Automatic Transfer Switch section shall be isolated from the Bypass Isolation Switch section by means of insulated barriers.

8. The bypass isolation switch shall be provided with indicating lights identifying location in bypass position, full isolation position, and source availability.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

D. The bypass isolation switch maybe located in the same enclosure as the automatic transfer switch or maybe located separately in a dedicated enclosure adjacent to the automatic transfer switch enclosure.

E. The bypass/isolation switch shall maintain a mechanical separation of the normal and emergency power sources to guard against the inadvertent connection of unsynchronized sources together. Electrical interlocking alone will not be considered acceptable.

2.04 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.

3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.

2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.

3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.05 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

2.06 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine transfer switches before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive transfer switches with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.

2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install transfer switches and accessories in accordance with manufacturer's instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Wall-Mounted Switch: Install transfer switches on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For transfer switches not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

D. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from enclosure and components.

1) Examine areas and conditions for compliance with requirements for medium-voltage transformers.

2) Examine roughing-in of conduits and grounding systems to verify the following:

(a) Wiring entries comply with layout requirements.

(b) Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

3) Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

4) Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be {CH#139615} ohms at location of transformer.

5) Proceed with installation only after unsatisfactory conditions have been corrected.

F. Mount equipment plumb and rigid without distortion of enclosure.

G. Arrange conductors in auxiliary compartments and gutters into groups and bundle and wrap with wire ties.

H. Comply with NECA 1.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.04 IDENTIFICATION

A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.

B. Device Nameplates: Label each main and bypass device with a nameplate.

C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

D. Diagram and Instructions:

1. Engraved, Laminated Acrylic or Melamine Label . Mount on front of transfer switch.

a) Operating Instructions: Printed operating instructions for transfer switch, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

b) System Power One-Line Diagrams: Provide color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room. Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance Instructions: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

3.05 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.07 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.08 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control tests and inspections.

B. Coordinate tests with tests of generator and run them concurrently.

C. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
3. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a) Check for electrical continuity of circuits and for short circuits.
    b) Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c) Verify that manual transfer warnings are properly placed.
    d) Perform manual transfer operation.
3. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a) Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b) Verify time-delay settings.
    c) Verify pickup and dropout voltages by data readout or inspection of control settings.
    d) Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

e) Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

5. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Transfer switches will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports, including a certified report that identifies transfer switches included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment, instrumentation, and accessories, and to use and reprogram microprocessor-based control, monitoring, and display functions.

B. Video record demonstrations presentation for Owner’s records.

C. Coordinate this training with that for generator equipment.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Permanently installed connection cabinets/docking stations with provisions for temporary power connections to portable equipment.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of electrical equipment with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Overcurrent Protective Device Coordination Study”

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections.

C. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.

D. Operation and Maintenance Data: Include detailed information on system operation, replacement parts, and recommended maintenance procedures and intervals.

E. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

F. Warranty

1.04 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.

2. Applicable local codes.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

C. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratories (NRTL), and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to components, enclosure, and finish.

1.06 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.07 WARRANTY

A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ESL Power Systems, Inc.; www.eslpwr.com

B. Foxfab Power Solutions; www.foxfab.com/#sle.

C. Schneider Electric; ASCO Power Technologies: www.ascopower.com/#sle.

D. Trystar; Trystar.com

2.02 CONNECTION CABINETS/DOCKING STATIONS

A. Description: Cabinets with provisions for temporary facility connection to portable generators and/or load banks.

B. General Requirements:

1. Listed as complying with UL 1008.
2. Temporary Connectors:
    a) Camlocks: Single-pole, series 16; 400 A rated.
    b) Lugs: Single-pole, mechanical type.
3. Input Camlock Connections for Generator: For each row, provide five camlock connectors (one for each phase, one for neutral, and one for ground).
4. Output Camlock Connections for Load Bank: For each row, provide four camlock connectors (one for each phase and one for ground).
5. Camlock Connector Color Code:
    a) 277 V to 480 V:
        1) Phase 1: Brown.
        2) Phase 2: Orange.
        3) Phase 3: Yellow.
    b) Neutral: White.
    c) Ground: Green.
6. Equipment Ground: Bonded to enclosure.
7. Bus Bar:
    a) Material: Tin-plated copper, unless otherwise indicated.
    b) Provide permanent connection to facility with mechanical set screw lugs.
8. Neutral Configuration:
    a) Input for Generator: 100 percent rated.
    b) Output for Load Bank: No neutral.

9. Temporary Cable Provisions: Provide access wiring entry/exit for conductors, with no sharp edges that may come in contact with conductor insulation.

C. Enclosure:

1. Material: Aluminum.
2. NEMA EN 10250 Rating: Type 3R.
3. Front Door: Lockable; capable of securing connection cables when locked.
4. Temporary Cable Access Panel: Hinged plate for bottom entry, mechanically interlocked with front door.
5. Finish Color: Manufacturer's standard.

D. Short Circuit Current Rating: Where not specified, provide connection cabinet with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.

E. Connection Cabinet:

1. Input/Output Configurations: Input for generator, male camlocks.
2. Main Disconnect: Sized as indicated on drawings..
3. Ground: Minimum 25 percent rated.
4. Phase Poles: As indicated on drawings.
5. Ampere Rating: As indicated on drawings.
6. Voltage for Color Codes: As indicated on drawings.
7. Mounting Configuration: Wall mounted.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1 for general workmanship.

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access; provide adequate space for temporary cable connections.

D. Provide required support and attachment; see Section 26 0529.

E. Install connection cabinets plumb and level.

F. Unless otherwise indicated, mount floor-mounted connection cabinets on properly sized concrete pad 3 inches in height.

G. Provide grounding and bonding; see Section 26 0526.

H. Provide identification; see Section 26 0553.

1. Identify system wiring and components.

2. Connection Cabinets for Portable Generators:

a) Use identification nameplate to identify phase rotation.

b) Use warning label or identification nameplate to identify system bonding requirements in accordance with NFPA 70.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes requirements for UL 96A Master Labeled lightning protection system consisting of air terminals on roofs, roof mounted mechanical equipment, stacks, bonding of structure and miscellaneous metal objects; Grounding electrodes; and interconnecting conductors.

B. System Design: Contractor shall perform all calculations and develop all plan and detail drawings required, in conjunction with these specifications, for installation of a complete and fully functional lightning protection system.

1.02 CODES, REFERENCES AND STANDARDS

A. Applicable Codes and Standards

1. NFPA 70 – National Electrical Code
2. UL 96 – Lightning Protection Components
3. UL 96A – Installation requirements for Lightning Protection Systems
4. NFPA 780 – Lightning Protection Systems
5. LPI 175 – Standard of Practice for the Design – Installation – Inspection of Lightning Protection Systems

1.03 DEFINITIONS

A. The following definitions apply to terms used in this section:

1. Air Terminal: A strike termination device that is a receptor for attachment of flashes to the lightning protection system and is UL listed for that purpose.
2. Bonding: An electrical connection between an electrically conductive object and a component of a lightning protection system that is intended to significantly reduce potential differences created by lightning currents.
3. Class I Materials: Lightning conductors, air terminals, ground terminals, and associated fittings required by NFPA 780 for protection of structures not exceeding 75 feet in height.
4. Class II Materials: Lightning conductors, air terminals, ground terminals, and associated fittings required by NFPA 780 for the protection of structures exceeding 75 feet in height.
5. Bonding conductor: A conductor intended to be used for equalization between grounded metal bodies and a lightning protection system.

6. Main conductor: A conductor intended to be used to carry lightning currents between strike termination devices (air terminals) and ground terminals.

7. UL: Underwriters Laboratories, Inc.

8. LPI: Lightning Protection Institute

1.04 SUBMITTALS

A. Product Data: Submit product data showing dimensions and materials of each component including listing in accordance with UL 96A.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system showing layout of air terminals grounding electrodes, and bonding connections, along with details of the components to be used in the installation.

2. Include indications for use of raceway, conductor sizes, roof and/or floor penetrations, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

3. Layout and installation drawings shall be fully coordinated with other trades. Failure of the lightning protection contractor to perform this coordination shall not relieve said contractor from properly completing the work.

C. Qualification Data: For qualified manufacturer. Include data on listing or certification by UL.

1. Manufacturer: A company specializing in lightning protection equipment with minimum 3 years documented experience and membership in good standing with the Lightning Protection Institute.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.

2. Ground loop conductor.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Certified by UL, trained and approved for installation of units required for this Project.

2. The contractor shall be recognized as being regularly engaged in the design and installation of lightning protection systems with a minimum of 3 years documented experience.

3. Include documentation of certification and experience with all submitted bids.

B. System Certificate:

1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.06 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. All materials used in the installation shall be new and shall comply in weight, size, and composition with UL 96 and NFPA 780. Materials shall be labeled or listed by UL for use on lightning protection systems.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.

1. Available Manufacturers:

a) East Coast Lightning Equipment Inc.

b) ERICO International Corporation.

c) Harger.

d) Heary Bros. Lightning Protection Co. Inc.

e) Independent Protection Co.

f) Preferred Lightning Protection.

g) Robbins Lightning, Inc.

h) Thompson Lightning Protection, Inc.

i) VFC

2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.

C. Main and Bonding Conductors: Copper and Class I.

D. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

2.02 SURGE PROECTIVE DEVICES

A. Surge Protective Devices SPD's required to meet UL 96A for UL Master Labeling shall be as specified in Division 26 Section "Surge Protective Devices".

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lightning protection components and systems according to UL 96A and NFPA 780.

C. Install conductors with two direct paths from air terminals to ground connections. Avoid sharp bends. Follow the manufacturer's written installation instructions.

D. Conceal the following conductors:

1. System conductors.

2. Down conductors.

3. Interior conductors.

4. Conductors within normal view of exterior locations at grade within 200 feet of building.

E. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

G. Air Terminals on Mechanical Equipment: Air terminals on mechanical equipment shall be mounted such that maintenance operations can be performed without relocation of the air terminal or interconnecting conductors.

H. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

I. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches from building foundation.

2. Bond ground terminals to the ground loop.

3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

4. Interconnect lightning protection ground loop with the building electrical service grounding electrode system at one place only.

J. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.02 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.03 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes field or factory-mounted Surge Protective Devices (SPDs) for low-voltage (120 to 600 V) power distribution and control equipment, including:

1. Surge Protection Devices at Service Entrance Equipment
2. Surge Protection Devices at Distribution Equipment
3. Surge Protection Devices at Branch Panelboards
4. Surge Protection Devices at Utilization Equipment
5. Surge Protection Devices in Electronic-Grade Panelboards

1.02 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. I*n* or In or I*nominal*: Nominal Discharge Current. Peak value of surge current, selected by the manufacturer, through the SPD having current wave shape of 8/20 microseconds where the SPD remains functional after 15 surges. I*n* is posted on the device UL label.

C. MCOV: Maximum Continuous Operating Voltage. The maximum continuous operating voltage rating of a Metal Oxide Varistor (MOV) that can be applied without the MOV being damaged and/or destroyed by thermal runaway. MCOV is posted on the device UL label.

D. SCCR: Short Circuit Current Rating. The maximum current rating the SPD can sustain without being damaged and/or destroyed. SCCR is posted on the device UL label.

E. SPD: Surge Protective Device: A broad class of protective devices, installed parallel with the distribution panel or service disconnect, meant to protect downstream electrical distribution equipment from the effects of high voltage surges on the line.

F. SPD Type definitions:

1. TYPE 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device. Type 1 devices are required for

Master Certification of Lightning Protection System installations under UL 96A.

2. TYPE 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch circuit panel.

3. TYPE 3: Point-of-utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, e.g., cord-connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance (10 meters or 30 feet) is exclusive of conductors provided with or used to attach SPD's.

4. TYPE 4: Component SPDs, including discrete components as well as component assemblies for installation on panelboards or control panels.

G. VPR: Voltage Protection Rating. The average of measured limiting voltage before and after Nominal Discharge Testing (In),) rounded up to one of UL's VPR categories (Indicated in the latest ANSI/UL 1449 edition) such as 330 volt, 400 volt, 500 volt, etc. VPR is posted on each device UL label.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."

B. Coordinate layout and installation of SPDs and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study".

D. Do not energize or connect any electrical or low voltage equipment to their sources until SPDs are installed and connected.

E. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

1.04 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each SPD type, accessory, component and enclosure indicated. Include dimensions and Manufacturer’s technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes. Tabulate model number, SPD type, system voltage, phases, modes of protection, MCOV, VPR, and I_n.

C. Shop Drawings: For SPDs.

1. Detail enclosure types and details.
2. Include general arrangement drawing showing dimensions and weights of each assembled device.
3. Include installation and mounting details for SPDs internal to equipment.
4. Detail bus connection configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus.
5. Detail short-circuit current rating of SPD assembly and overcurrent protective devices.
6. Include schematic and wiring diagrams for power, signal, and control wiring.
7. Include insertion loss bode plots.
8. Include nameplate legends.
9. Include list of materials.

D. Product Certificates: For SPD devices, from manufacturer.

E. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.

F. Qualification Data: For qualified testing agency.

G. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

H. Manufacturer's field service report.

I. Sample Warranty: For warranty.

J. Project Record Documents: Record actual installed equipment and circuiting arrangements.

K. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for SPDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting SPDs.
3. Time-current curves for each type of overcurrent protective device.
4. Features and operating sequences, both automatic and manual.
5. Video recording of operation training and demonstration.

L. Follow-up service reports.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Source Limitations: Obtain SPDs of each type and associated components and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

E. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

F. Comply with NEMA LS 1.

G. Comply with UL 1283 and ANSI/ UL 1449.

H. Comply with NFPA 70.

I. The SPD shall be compliant with the restrictions of the Hazardous Substances (RoHS) Directive 2002/95/EC.

1.06 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not install SPDs until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above equipment. Provide temporary HVAC

system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a) Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

b) Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

c) Humidity: 0 to 85 percent, noncondensing.

d) Altitude: Less than 20,000 feet (6090 m) above sea level.

C. Interruption of Existing Electrical Service: Refer to Division 26, Section “General Electrical Requirements”.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish.

B. Handle and prepare SPD components according to manufacturer's written instructions.

1.08 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Internally mounted and externally mounted SPD’s shall be provided by the same manufacturer. Coordinate with switchboard and panelboard manufacturers as required.

B. Manufacturers:

1. ABB USA.
2. Eaton
3. Intermatic, Inc.
4. LEA International.
5. Leviton Mfg. Company Inc.
6. Siemens.
7. Schneider Electric.
8. Surge Suppression Incorporated.
9. Vertiv.

C. Surge Protective Device Ratings: Device type ratings shall be:

1. Type 1 - Service entrances
2. Type 2 - Service entrance equipment or distribution equipment
3. Type 3 - Utilization equipment or point of use.

D. Nominal System Voltage: Match the system voltage to which the SPD is connected, as indicated on the drawings.

E. Maximum Continuous Operating Voltage: Not less than 125 percent of nominal system voltage for 240V or less power systems, and not less than 115 percent of nominal system voltage for 600V and 480V power systems.

F. Comply with ANSI/UL 1449.

G. SPDs for Lightning Protection: For Lightning Protection Systems specified or otherwise required to be "Master Labeled" per UL 96A utilize Type 1 (20kA rated I_n) SPDs.

2.02 SURGE PROTECTION DEVICES AT SERVICE ENTRANCE EQUIPMENT

A. Surge Protection Devices: Externally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
4. LED indicator lights for power and protection status.
5. Six-digit transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I*n*): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 1 SPD's shall be tested and labeled at 20kA per mode.

2. Type 2 SPD's shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200kA. Peak surge current rating must be arithmetic sum of the ratins of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2.03 SURGE PROTECTION DEVICES AT DISTRIBUTION EQUIPMENT

A. Surge Protection Devices: Externally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.

2. Fabrication using bolted compression lugs for internal wiring.

3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

4. LED indicator lights for power and protection status.

5. Six-digit transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I*n*): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 2 SPD's shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 150kA. Peak surge current rating must be arithmetic sum of the ratins of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 240/120 V circuits shall be as follows:

2.04 SURGE PROTECTION DEVICES AT BRANCH PANLEBOARDS

A. Surge Protection Devices: Externally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
4. LED indicator lights for power and protection status.
5. Four-digit transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I*n*): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 2 SPD's shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100kA. Peak surge current rating must be arithmetic sum of the ratins of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 240/120 V circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1400 from high leg
Line to Ground	1000	1000, 1400 from high leg

Neutral to Ground	700	700

2.05 SURGE PROTECTION DEVICES AT UTILIZATION EQUIPMENT

A. Surge Protection Devices: Externally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fabrication using bolted compression lugs for internal wiring.
2. Integral disconnect switch.
3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
4. LED indicator lights for power and protection status.

B. Nominal Discharge current (I*n*): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 3 SPD's shall be tested and labeled at 10kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 80kA. Peak surge current rating must be arithmetic sum of the ratins of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 240/120 V circuits shall be as follows:

2.06 SURGE PROTECTION IN ELECTRONIC-GRADE PANELBOARDS

A. Surge Protection Devices: Integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fabrication using bolted compression lugs for internal wiring.
2. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
3. LED indicator lights for power and protection status.

B. Nominal Discharge current (I*n*): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 2 SPD's shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100kA. Peak surge current rating must be arithmetic sum of the ratins of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 240/120 V circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1400 from high leg
Line to Ground	1000	1000, 1400 from high leg
Neutral to Ground	700	700

2.07 ENCLOSURES

A. All SPD Units shall be fully enclosed unless otherwise noted. Provide enclosures suitable for the locations indicated and as described below:

1. Indoor Enclosures:

a) NEMA 250 Type 1 constructed of a polymer or steel material

2. Outdoor Enclosures:

a) NEMA 250 Type 3R constructed of steel material and with a gasket to exclude dirt, windblown dust, and water (rain, sleet, and snow) from entering the enclosure when shut.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surge suppression devices before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive SPDs with Installer present, for compliance with requirements for installation tolerances, structural

support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install SPDs and accessories in accordance with manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.

C. Wall-Mounted Surge Protective Devices: Install SPDs on walls adjacent to equipment served, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For SPDs not at walls, mount to similar support structure for equipment served by device. Comply with Division 26 Section "Hangers and Supports for Electrical Systems."

D. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

E. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

F. Mount equipment plumb and rigid without distortion of enclosure.

G. Install fuses in fusible devices.

H. Comply with NECA 1.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Connect to building automation system according to Division 26 Section “Electrical Power Monitoring and Control.”

3.04 IDENTIFICATION

A. Nameplates: Label external device enclosures with equipment served.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

C. Warning Labels: Label device with a warning label in accordance with NFPA 70 and NFPA 70E.

3.05 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.07 FIELD QUALITY CONTROL

A. Testing: Perform the field tests and inspections listed below :

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.

B. Acceptance Testing Preparation:

1. After installing SPD but before equipment is energized, test for compliance with requirements.
2. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
3. Complete startup checks according to manufacturer's written instructions.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. SPD device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protectiv devices, instrumentation, and accessories.

B. Video record demonstrations presentation for Owner's records.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:

1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, transformers, drivers and power supplies (includes exterior light fixtures normally installed on exterior surfaces of buildings).
2. LED Emergency Driver
3. Exit signs.
4. Emergency Lighting Mini-Inverter.

1.02 DEFINITIONS

A. CCT: Correlated color temperature

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. IC Rated: Rated for direct contact with insulation.

E. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs

F. LED: Light Emitting Diode

G. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.

H. LED Module or LED Light Engine: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.

I. LER: Light fixture (Luminaire) efficiency rating.

J. Light Fixture: Complete light fixture, including driver housing if provided.

K. LPD: Lighting power density.

L. RCR: Room cavity ratio.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment, fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work

C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.

D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.

E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.04 SUBMITTALS

A. General:

1. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
2. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
3. Modifications to fixtures shall be in accordance with Contract Administrator's comments.

B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type
   a) The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
   b) Light fixture driver or auxiliary device manufacturer, number and type.
2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.

a) Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.

3. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.

4. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.

5. Emergency driver cut sheet: Descriptive cut sheets providing physical description of emergency drivers for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.

C. Submittal Schedule

1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to Contract Administrator to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.

2. Within 15 days of "approved" and "approved as noted" shop drawings, contractor shall forward to Contract Administrator a guaranteed ship date for each specified fixture.

3. Within 15 days after contractor's receipt of "reject and resubmit" or "not approved" shop drawings, contractor shall provide Contract Administrator with resubmitted shop drawings for only those fixtures deemed unacceptable.

4. Contractor is responsible to call to the attention of the Contract Administrator any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures.

D. Control Wiring

E. Qualification Data: For agencies providing photometric data for light fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.05 SUBSTITUTIONS

A. Refer to Division 26 Section “General Electrical Requirements”.

B. Prior to the Bid Date, substitutions will not be considered unless the Contracto Administrator has received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an evaluation. Provide interior point-by-point photometric calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a $100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.

C. During the Bid

1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.

2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:

   a) Agents can group only specified fixtures they represent, and

   b) Only represent in the region where the specification originated, and

   c) Exclude all fixtures outside their represented lines from the MLP, and

   d) Sole-sourced (proprietary) light fixtures shall not be included in the MLP.

3. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.

D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Contract Adminstrator.

E. During the construction period, no substitutions shall be considered if product delay is due to contractor’s failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor’s error shall be at the expense of contractor.

F. The Contract Administrator has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

2. Marked for intended use.

B. Comply with NFPA 70.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

E. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.

F. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.

1.07 WARRANTY

A. General Guarantee: For a period of one year after Owner’s initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Special Warranty paragraph in this section. Contractor shall repair installed equipment on the job site to Owner’s satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.

B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.

C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.

1. LED Luminaires, including LED modules, arrays and drivers: Five years.

2. LED Lamps: Three years.

D. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: _____ years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.

2. Warranty Period for LED Emergency Driver and Self-Powered Exit Sign _____ years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturers

1. In Light Fixture Schedule, the following requirements apply to product selection:

a) Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.

B. Light Fixtures and Components

1. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.

2. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.

3. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.

4. Metal Parts: Free of burrs and sharp corners and edges.

5. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

7. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

    a) White Surfaces: 85 percent.

    b) Specular Surfaces: 83 percent.

    c) Diffusing Specular Surfaces: 75 percent.

    d) Laminated Silver Metallized Film: 90 percent.

8. Plastic Diffusers, Covers, and Globes:

    a) Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

        1) Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.

        2) UV stabilized.

    b) Glass: Annealed crystal glass, unless otherwise indicated.

9. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.

10. Reflectors:

    a) Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish :Alzak" with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and

semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.

11. Mounting hardware and trims:

    a) Coordinate as need to suit ceiling conditions.

    b) Light fixtures near or in contact with insulation shall comply with code.

    c) Maintain a 3” minimum working clearance between non-IC rated light future housings and insulation on all adjacent ductwork, piping, walls and ceilings.

12. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

    a) Label shall include the following lamp, LEDs, and driver characteristics:

        1) "USE ONLY" and include specific lamp or LED type.

            (a) LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.

            (b) CCT and CRI for all luminaires.

13. Emergency lights and exit signs with integral battery back-up shall be connected to a separate unswitched conductor bypassing all other controls and contactors. Exit signs shall not be switched. Allow battery to charge for a minimum of 48 hours before light level testing. In order to prevent battery damage, do not turn off power for extended periods of time after the emergency light has been powered.

2.02 LED EMERGENCY DRIVER

A. Internal Type: Self-contained battery, charger, and electronic circuitry, factory mounted within light fixture body and compatible with driver. Comply with UL 924.

1. Emergency Connection: Provide wattage as scheduled on drawings to an LED load. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.

2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a) Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

    b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

3. Battery: Sealed, high-temperature, maintenance-free, nickel-cadmium or lithium ion type. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 87 1/ 2 percent of the nominal battery voltage for the total lamp load associated with the unit for a period of at least 1 1/ 2 hours, or the unit equipment shall supply and maintain not less than 60 percent of the initial emergency illumination for a period of at least 1 1/ 2 hours.

4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

5. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

B. External Type: Self-contained battery, charger, and electronic circuitry, compatible with driver, remote mounted from light fixture. Comply with UL 924.

1. Emergency Connection: Provide wattage as scheduled on drawings to an LED load. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.

2. Battery: Sealed, high-temperature, maintenance-free, nickel-cadmium or lithium ion type. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 87 1/ 2 percent of the nominal battery voltage for the total lamp load associated with the unit for a period of at least 1 1/ 2 hours, or the unit equipment shall supply and maintain not less than 60 percent of the initial emergency illumination for a period of at least 1 1/ 2 hours.

3. Charger: Fully automatic, solid-state, constant-current type.

4. Housing: NEMA 250, Type 1 enclosure.

5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.03 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a) Battery: Sealed, maintenance-free. Battery chemistry type shall be appropriate for installed environment.

b) Charger: Fully automatic, solid-state type with sealed transfer relay.

c) Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d) Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.04 EMERGENCY LIGHTING MINI-INVERTER

A. Manufacturer

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a) Bodine (by Signify),

b) Carpenter Emergency Lighting,

c) Chloride (by Signify),

d) Controlled Power Company,

e) Cooper Lighting,

f) DSPM, Inc,

g) Dual Lite,

h) Emergi-Lite,

i) Iota Engineering (Acuity Brands),

j) Inverter Systems, Inc (ISI),

k) Myers Emergency Power Systems,

B. Description – Self-contained uninterruptible or fast-transfer inverter designed for normal and emergency operation of connected lighting loads. Unit shall be capable of operating HID, incandescent, fluorescent, induction and LED fixtures with no break or interruption of illumination. UL 924 listed and meets NFPA 101, NFPA 70 and local codes.

1. Battery: Sealed, maintenance-free. Battery chemistry type shall be appropriate for installed environment. 68 degrees Fahrenheit to 86 degrees Fahrenheit optimum operating temperature.
2. Charger and Electronics: Fully automatic, thermal compensating variable rate battery charger. AC lockout feature, low battery voltage disconnect; DC overload, short circuit and brownout protection. 32 degrees Fahrenheit to 104 degrees Fahrenheit electronics operating temperature.
3. Operation: Inverter shall allow connected emergency lighting fixtures to be normally on. Upon loss of normal utility power, the emergency lighting fixtures will be delivered emergency power for their full lumen output rating with no break (???2 ms) in illumination for a minimum of 90 minutes.
4. 120V, single phase input and output voltages. Input voltage shall match output voltage, and +/- 3% voltage regulation, 60 Hz.
5. Maximum remote mounting distance of 1000’-0”.
6. Housing: Designed for surface mounting installation to floor or wall. 16 gauge steel housing with scratch-resistant powder coat paint finish..
7. Testing: Integral testing means by either manual test switch or self-testing, self-diagnostic with manual testing capabilities.
8. Onboard LED indicating lights for inverter status indication.
9. Manufacturer’s warranty or minimum 2 year warranty on electronics and battery and seven-year prorata warranty on battery, whichever is greater.
10. Overload and short circuit protection on input and output of inverter. Circuit breakers or fusing on output side.

C. Where wattage of inverter is different from Basis-of-Design manufacturer’s selected wattage, provide quantity of inverters as required to meet design intent. If additional inverters are required, confirm additional equipment will fit within available space constraints.

D. Where physical size of inverter is different from Basis-of-Design manufacturer, confirm equipment will fit within available space constraints.

2.05 LAMPS GENERAL

A. Unless specific manufacturers and lamp types are called for in the Light Fixture Schedule, all lamps provided for this project shall be by the same manufacturer. Lamps shall be manufactured by:

1. Eiko
2. General Electric
3. Osram/Sylvania
4. Philips
5. Soraa
6. Venture

B. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package.

C. Substitutions of specific lamp manufacturer as addressed in Fixture Schedule shall not be allowed. Costs associated with re-lamping due to non-compliance with specification, for both labor and material costs, shall be the sole responsibility of the contractor. For those fixtures with lamp included in fixture, contractor shall coordinate with manufacturer to ensure only approved lamp(s) is (are) installed. Lamp manufacturers indicated on Fixture Schedule are for reference. Where required, contractor shall coordinate with Owner regarding national purchasing agreement of specific lamp manufacturers. Purchasing of lamps, whether through competitive bidding of listed manufacturers or proprietary supply, shall be at the discretion of the Owner.

2.06 LED LAMPS AND LUMINAIRES

A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 3000K CCT.

B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.

C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:

1. LED lamps: 20,000 hours
2. LED luminaires: 50,0000 hours

D. ROHS compliant

E. Manufacturer of LED chips will be evaluated based on the manufacturer’s product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Contract Administrator or Engineer has the authority to

reject other manufacturers for technical or aesthetic reasons if felt necessary or desireable.

2.07 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.08 LIGHT FIXTURE SUPPORT COMPONENTS

A. Comply with Section "260529 - Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

2.09 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

A. Provide transformers to low voltage lamps which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers so as to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy-chain 25A loaded runs together. Contractor shall provide home-run from end of run to remote transformer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

C. Temporary Lighting: If it is necessary, and approved by Contract Administrator, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

D. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.

2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

E. Suspended Light Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.

F. Connect wiring according to Section "260519 - Low-Voltage Electrical Power Conductors and Cables."

G. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.

H. Wall Mounted Light fixtures

1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Contract Administrator prior to installation. Contractor shall supply structure to support weight of fixture.

I. Contractor shall construct light coves according to architectural details. Contractor shall ensure, unless otherwise directed, that top of fixture lamp is flush with top of cove lip. Contractor shall provide blocking as needed under fixture to ensure stated requirement.

J. Auxiliary Devices for low voltage and LED Fixtures

1. Install device within maximum remote distances and with wiring sized per manufacturer’s recommendations.

2. In public areas or other areas where remote device visibility is undesireable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.

3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.

4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

3.03 DIMMING

A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:

1. 0-10V – two low voltage conductors and two line voltage conductors plus ground

2. 2-Wire dimming – two line voltage conductors plus ground

3. 3-Wire dimming – three line voltage conductors (1 for control and two for power) plus ground

4. DALI – two low voltage conductors and two line voltage conductors plus ground

5. Proprietary digitally addressable – as required per the manufacturer

6. DMX – two line voltage conductors plus ground and DMX cabling

B. Coordinate light fixture and control device dimming types for compatibility.

3.04 COORDINATION

A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.

B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.

C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

D. Coordinate final light fuxture locations in walk-in coolers and freezers with refrigeration coils and other trades.

E. Wall-Mounted Light fixtures

1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Contract Administrator prior to beginning any work.

3.05 ADJUSTING

A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Contract Administrator.

3.06 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.

C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. References
2. Administrative Requirements
3. Action Submittals
4. Informational Submittals
5. Closeout Submittals
6. Quality Assurance
7. Delivery, Storage, and Handling
8. Warranty
9. Components
10. Examination
11. Installation
12. Field Quality Control
13. Cleaning
14. Closeout Activities

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. AHJ – Authority Having Jurisdiction
2. ANSI – American National Standards Institute
3. AV – Audio Video
4. BABA – Build America Buy America
5. BICSI – Building Industry Consulting Services International
6. EPD – Environmental Product Declaration
7. ESS – Electronic Safety and Security
8. HPD – Health Product Declaration
9. ICT – Information and Communications Technology
10. IDF – Intermediate Distribution Frame
11. ISO – International Organization for Standardization
12. LEED – Leadership in Energy and Environmental Design
13. MDF – Main Distribution Frame
14. NFPA – National Fire Protection Association
15. OSHA – Occupational Safety and Health Administration
16. TAA – Trade Agreements Act
17. TDMM – Telecommunications Distribution Methods Manual
18. TIA – Telecommunications Industry Association
19. TR – Telecommunications Room

B. Definitions:

1. As-built – The documentation of measurements, location, and quantities of material work performed.
2. Comply – To conform, submit, or adapt as required or requested.
3. Consultant – A specialist who provides services to the design team headed up by an architect or engineer under contract with a client.
4. Contract – A written document covering the understanding between the customer and the contractor.
5. Contract documents – Plans, specifications, and other documents that together set forth the requirements of the contract and become legally enforceable when the agreement is signed. Executed agreements between the owner and contractor that become part of a contract when the agreement is signed.
6. Coordinate – To bring into a common action, movement, or condition.
7. Deferred Submittal – A building code issue that allows the final design to be submitted after the permit has been issued. Deferred submittals are portions of the design that are not submitted by the design team at the time of building permit application. They are typically performed by a specialty engineer.
8. Delegated Design – A contractual issue between the owner and the contractor. The design professional or architect of record establishes the performance requirements for an element of a building, and a contractor assumes the responsibility of designing that element.
9. Furnish – To supply and deliver to the project site, ready for installation.
10. Install – To place in a position of service or use.
11. Pathway – Any physical method of supporting, enclosing, protecting, or otherwise transporting wiring systems.
12. Provide – To furnish and install, complete and ready for intended use.
13. Punch list – A short list of tasks that are required to be completed in order to close out a work order or project.
14. Raceway – Any enclosed physical pathway designed to protect or shield premises wiring systems.
15. Shall – Frequently used in codes and standards publications, the term indicates a mandatory requirement.
16. Shop drawings – Drawings, diagrams, schedules, and other data specially prepared for the work by the Contractor or a subcontractor, sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the work.
17. Should – Indicates a recommendation or that which is advised but not required.
18. Submittal – Information, documentation, or samples that a contractor may be requested to submit to the design team for review and approval before the commencement of work.
19. Substantial completion – A stage of construction or a building project that is sufficiently complete, in accordance with the contract documents, so that the owner may use or occupy the building project.
20. Record drawings – Construction drawings revised to reflect and represent the actual conditions of the project as it was constructed, usually based on marked-up prints, drawings, and other data furnished by the contractor to the architect.

C. Reference Standards:

1. ANSI/TIA-568.0-E, Generic Telecommunications Cabling for Customer Premises
2. ANSI/TIA-568.1-E, Commercial Building Telecommunications Infrastructure Standard
3. ANSI/TIA-569-E, Telecommunications Pathways and Spaces
4. BICSI TDMM, 14th edition
5. ISO 9001 – Quality Management
6. NFPA 70®, National Electrical Code® (NEC) (currently adopted edition)

1.03 ADMINISTRATIVE REQUIREMENTS

A. See Section 01 31 00 – Project Management and Coordination, for additional information.
B. Coordination:

1. Examine drawings and specifications for the entire project. Notify the Architect, General Contractor, or Consultant of discrepancies upon discovery.
2. Coordinate shut-downs, cutovers, or tie-ins with the Owner as required. Submit schedule for approval at least 2 weeks in advance.
3. Coordinate work with the Architect, General Contractor, and Subcontractors:

a. Converged cabling responsibilities:

1) Division 27 AV Contractor
2) Division 28 ESS Contractor

b. Deliverables:

1) General Contractor
2) Owner

c. Inspections:

1) AHJ

d. MDF/IDF:

1) Division 21 Contractor, for sprinkler head locations
2) Division 23 Contractor, for cooling requirements
3) Division 26 Contractor, for electrical, lighting, and bonding requirements
4) Division 27 and 28 Contractors, for equipment locations
5) General Contractor, for plywood backboard installation requirements

e. Rough-in, receptacle, conduit, cable tray, and underground pathway requirements:

1) Division 26 Contractor

C. Pre-installation meetings:

1. Convene pre-installation meetings with the Owner, Architect, Consultant, General Contractor, and other Subcontractors within 30 days before beginning work.
2. Meetings shall consist of construction drawing and specification review, submittal expectations, and project review.

D. Scheduling:

1. Coordinate, plan, and execute work according to the project schedule.
2. Adhere to project milestones and implementation schedule.
3. Submit a detailed schedule of installation milestones in the form of a Gantt chart to the design team and General Contractor within 30 days before beginning work.

1.04 ACTION SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures, for additional information.

B. Product Data:

1. Submit product data in .pdf format for review no later than 60 days before beginning work. Products ordered or installed before receiving reviewed and returned submittals are subject to removal and replacement at the Contractor's expense.
2. Submit product data individually for each specification section under separate cover. Product data submittal shall include all certificates and material listed in the specification section.

    a. Submit cut sheets with part numbers, model numbers, and brief descriptions. Clearly indicate the product on each product data sheet using yellow highlighter.

3. Include a title sheet with the following information:

    a. Contractor name and contact information
    b. Date of submittal
    c. Project name
    d. Project number
    e. Sequential submittal number
    f. Specification section reference

4. Full-line and short-form catalogs are not acceptable.
5. Remove pages without part numbers and basic product descriptions, extraneous pages, blank pages, and repeated information.
6. Keep information pertinent to technical data only and as brief as possible.
7. Submittals will be reviewed for general compliance and not quantities. Individual submittals reviewed more than twice are subject to back charges being levied against the Contractor. Resubmittals shall be designated with a revision number beginning with R1 and increasing consecutively.
8. Combined submittals, submittals submitted under the incorrect specification section, submittals with extraneous pages, submittals with incorrect product data, or unapproved substitutions will be rejected.
9. Identify products with long lead times and anticipated ship dates that may affect the project schedule.

C. Shop Drawings:

1. Submit shop drawings in .pdf format, similar to the contract drawings, for review no later than 60 days before beginning work.
2. Create shop drawings from project Revit backgrounds. Shop drawings created using design team-issued contract drawings will not be accepted.
3. Shop drawings can be submitted as 1 complete set per discipline.

    a. Include the MDF, each IDF, cable tray pathways, conduit pathways, underground pathways, telecommunications outlet locations with field labeling, rack elevations, and backbone and bonding riser diagrams. Drawings and elevations created with Microsoft Visio are not permitted.

4. Include a title sheet with the following information:

    a. Contractor name and contact information
    b. Date of submittal
    c. Drawing reference
    d. Project name
    e. Project number

f. Sequential submittal number

5. Submit shop drawings on 24-inch by 36-inch (Architectural size D) sheets.
6. Scale shop drawings at an appropriate scale, but not smaller than 1/8-inch equals 1 foot.
7. Include sufficient information to describe the work being performed.
8. Shop drawings will be reviewed for general compliance and not dimensions or quantities. Shop drawings reviewed more than twice are subject to back charges being levied against the Contractor.

1.05 INFORMATIONAL SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures, for additional information.
B. Certificates:

1. Submit certificates in .pdf format for review no later than 60 days before beginning work.
2. Submit certificates for each specification section with the associated product data.

a. BICSI:

1) RCDD
2) Technician
3) Installer 1 or 2

b. Manufacturer:

1) Cable and connectivity manufacturer certification for the company, Project Manager, and ICT installers.

c. Manufacturer reports:

1) Submit documentation stating that materials and products are BABA or TAA-compliant.

d. Sustainable Design Submittals:

1) Submit sustainable practice documentation for project materials and products from at least 1 of the following:

a) EPDs: Provide EPDs verified through UL Environment, a division of the safety science company UL.
b) HPDs: Provide reports published according to the Health Product Declaration Collaborative™ Standard.
c) LEED credits: Provide products that contribute towards LEED credits through EPDs and HPDs as well as the LEED certificate from the manufacturer.
d) Multi-Attribute Certifications: Provide certifications published through GreenCircle Certified, LLC, in accordance with internationally recognized standards and the Federal Trade Commission’s Green Guides.
e) Zero Waste to Landfill: Provide certification recognizing the achievement of a 100 percent landfill waste diversion rate.

1.06 CLOSEOUT SUBMITTALS

A. See Section 01 77 00 – Closeout Procedures, for additional information.
B. Format:

1. Submit closeout submittals in .pdf format to the Owner and Consultant for review and approval as soon as they are complete, but no later than 60 days before the date of substantial completion.

a. Include the following:

1) Warranty documentation:

a) Manufacturer warranties

2) Record documentation:

a) As-builts

3) Test reports:

a) Bonding test results
b) Copper cable test results
c) Optical fiber test results

4) Cable Matrix:

a) See Section 27 15 13 – Communications Copper Horizontal Cabling, for more information.

C. Warranty Documentation:

1. Submit authorized manufacturer warranty documentation as specified in other sections.

D. Record Documentation:

1. As-builts:

a. Include the MDF, each IDF, cable tray pathways, conduit pathways, underground pathways, and telecommunications outlet locations, including CCTV and AV, with field labeling, elevations, and riser diagrams. Remove references to project changes.
b. Submit 1 soft copy set of As-builts to the Owner after the review and approval process is complete. Create As-builts on 24-inch by 36-inch (Architectural size D) sheets.
c. Create As-builts from project Revit files. As-builts created from .pdf documents or other means will not be accepted.
d. Submit As-builts in .pdf and .rvt format.

2. Record Drawings:

a. Maintain a complete set of drawings and specifications at the job site to clearly and permanently mark changes made. Transfer changes to As-builts.
b. Create record drawings from project Revit files. Record drawings created from .pdf documents or other means will not be accepted.

c. Submit redlined record drawings in .pdf and .rvt format.
d. Submit redlined specification changes in .pdf format.

E. Test Reports:

1. See Section 27 05 26 – Grounding and Bonding for Communications Systems, for test report information.
2. See Section 27 13 13 – Communications Copper Backbone Cabling, for test report information.
3. See Section 27 13 23 – Communications Optical Fiber Backbone Cabling, for test report information.
4. See Section 27 15 13 – Communications Copper Horizontal Cabling, for test report information.
5. See Section 27 15 23 – Communications Optical Fiber Horizontal Cabling, for test report information.

1.07 QUALITY ASSURANCE

A. See Section 01 40 00 – Quality Requirements, for additional information.
B. Qualifications:

1. Installers:

a. The project requires certified installers experienced with similar installations in size and complexity.

2. Certifications:

a. Division 27 Cabling Contractor:

1) Minimum 1 current BICSI RCDD on staff as a full-time employee that shall regularly inspect work, stamp shop drawings, and review and stamp test results.
2) Minimum 1 current BICSI Technician on staff as a full-time employee who shall serve as the Project Manager.
3) Minimum 1 current BICSI Installer 1 or 2 involved with the installation.
4) Current cable manufacturer certification is required for the company, Project Manager, and installers. Clearly indicate which certified employee will be the Project Manager.

3. Project Management:

a. Assign a Project Manager to the project. Project Manager responsibilities include:

1) Completing and submitting the required documentation.
2) Continuously overseeing and directing the work and performance of employees and subcontractors.
3) Documenting and completing the punch list.
4) Ensuring completion of the scope of work on time.
5) Ensuring compliance with the contract documents.
6) Regularly inspecting work.
7) Reporting unexpected conditions that may result in delays or additional costs.
8) Scheduling cutovers or tie-ins.

C. Construction Observation:

1. The failure of the Consultant or another representative of the Architect or Owner to condemn any defective work or material shall not release the Contractor from the obligation to tear out, remove, repair, or replace upon discovery of non-conforming work or material at any time during the project.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Coordinate with the General Contractor for any equipment, products, and materials to be delivered on-site.

B. Storage and Handling Requirements:

1. Coordinate with the General Contractor for any equipment, products, and materials to be stored on-site.
2. Store and protect products and materials following manufacturer recommendations.
3. Provide secure storage for equipment, products, and materials stored on-site.
4. Follow manufacturer guidelines on proper storage for material.

1.09 WARRANTY

A. Manufacturer Warranty:

1. The cable manufacturer shall have a minimum of a 20-year warranty on its products. The warranty shall cover the cable and associated components against defects in material and workmanship under normal use.

PART 2 - PRODUCTS

2.01 COMPONENTS

A. Manufacturers:

1. See Section 01 60 00 – Product Requirements, for additional information.
2. See Division 27 specification sections for product and material requirements.
3. Products shall be new, unused, and in the original packaging.
4. Products and materials used to accomplish project goals shall meet listed standards and be manufactured to ISO 9001 standards.
5. Products specified are intended to establish a baseline for operational, functional, and performance-based standards that proposed products shall meet or exceed by functionality and quality.
6. Products listed within Division 27 specifications shall be provided as part of a complete and functioning system unless determined otherwise by the Owner, Architect, or Consultant during the submittal process.
7. Provide incidental items required for a complete installation regardless of whether they are specified.

B. Substitution Limitations:

1. See Section 01 25 00 – Substitution Procedures, for additional information.
2. Specified products and materials establish the overall performance level and provide the physical appearance, part quality, construction quality, and background of proven reliability desired by the Owner and therefore define the minimum standards of quality required for the project. Certain products are not permitted to be substituted and are listed as “Substitutions: Not permitted.” Provide substitution requests for products permitted to be substituted. Substitution requests must contain sufficient information verifying equivalency to specified items or can be procured at a lower price to be considered for an approved substitution and shall be submitted before the bid date. Substitution requests submitted after the bid has been awarded will not be accepted without justification. See Section 01 25 00 – Substitution Procedures, for pre-bid substitution forms and requirements.
3. Installed products or materials that deviate from specified or submitted make, model, color, or other significant characteristics will be replaced by the Contractor with specified or submitted products at no additional cost and without impact on the construction schedule.

C. Product Options:

1. Procure material from local distribution sources. Utilize multiple local distribution sources to avoid procuring material from non-local sources.

D. Sustainability Requirements:

1. Provide materials and products that contribute to sustainable practices. Materials and products shall offer EPDs, HPDs, LEED credits, and Multi-Attribute Certifications. Products that do not contribute to sustainable practices will be rejected.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Perform a site survey before beginning work. Site surveys shall include pathways, raceways, space allocations, installation tolerances, installation hazards, and impediments affecting the installation.
2. Notify the General Contractor of conflicts, discrepancies, or omissions promptly upon discovery. Failure to adequately complete a site survey will not provide a basis for additional compensation.
3. Commencement of work without providing notification to the General Contractor indicates acceptance of conditions.
4. Errors and omissions in the drawings or specifications do not relieve the Contractor from performing omitted details of the work.
5. Verify quantities for equipment, cabling, components, and materials before submitting the bid.

3.02 INSTALLATION

A. See Section 01 73 00 – Execution, for additional information.

B. Systems Integration:

1. Field measure indicated mounting heights, as shown on the contract drawings. If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum headroom and working clearance.
2. Furnish labor, materials, tools, equipment, and services for the installation under general provisions of contract documents.
3. Provide supplementary or miscellaneous items and incidental devices necessary for a complete installation, whether specifically indicated in the contract documents.
4. Install products, materials, and equipment to facilitate service, repair, or replacement.
5. Execute work following NEC, OSHA, Fire Code, and BICSI standards, manufacturer written instructions or recommendations, and applicable codes. Where modifications are required due to code, regulations, or authorities, such changes shall be made without additional cost.
6. Follow industry standards of good practice for installations.
7. Products and materials shall be installed plumb, level, square, permanently attached, and held firmly in place.
8. Verify conduit, back boxes, junction boxes, pathways, raceways, and electrical requirements meet size and project requirements.

3.03 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

1. Tests:

a. Test bonding, optical fiber, and copper cabling as specified in the following sections:

1) Section 27 05 26 – Grounding and Bonding for Communications Systems.
2) Section 27 13 13 – Communications Copper Backbone Cabling.
3) Section 27 13 23 – Communications Optical Fiber Backbone Cabling.
4) Section 27 15 13 – Communications Copper Horizontal Cabling.
5) Section 27 15 23 – Communications Optical Fiber Horizontal Cabling.

b. The Owner, Architect, or Consultant may elect to verify test data as part of the acceptance procedure. Provide personnel and testing equipment at no additional cost.

2. Inspections:

a. Inspections for appropriate installation practices are the responsibility of the Project Manager.
b. At the discretion of the Owner, Architect, or Consultant, provide personnel for periodic inspections, including a final inspection, at mutually agreed-upon times at no additional cost.
c. Scheduled inspections in which the work is deemed incomplete, unfinished, or otherwise not ready for inspection are subject to back charges being levied against the Contractor.

B. Non-Conforming Work:

1. See Section 01 77 00 – Closeout Procedures, for additional requirements.

2. Work found to be incomplete, unsatisfactory quality, failing to meet specifications, or unacceptable to the Owner, Architect, or Consultant will be documented as a non-conforming work notice, field observation, or punch list and provided to rectify at no additional cost. Provide written notification with pictures upon completion. Incomplete lists will be rejected.
3. The non-conforming work notice, field observation, or punch list will be considered complete only after being signed off by the Owner, Architect, or Consultant.

3.04 CLEANING

A. See Section 01 74 19 – Construction Waste Management and Disposal, for additional information.
B. Waste Management:

1. Remove trash and refuse after each workday.
2. Coordinate with the General Contractor for disposal of packaging and waste materials created during work to an approved common trash or recycling point or receptacle.
3. Keep work area neat, tidy, and free from accumulating waste materials.
4. Remove foreign material, dust, dirt, paint, unneeded labels, and stickers from equipment after completion.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 79 00 – Demonstration and Training, for additional information.
B. See Division 27 sections for closeout activities.

END OF SECTION 27 05 00

SECTION 270529

PATHWAYS FOR AV SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conduits
B. Pull Boxes
C. Conduit Fittings
D. Floor Boxes
E. Cable Tray

1.02 DESCRIPTION OF WORK

A. Furnish and install all items listed in 1.1 required to support the AV systems cabling as indicated on the AV drawings, specified, or as otherwise required.

PART 2 - PRODUCTS

2.01 General

A. Refer to AV Drawings for pathway type required for each cable run. Substitution of pathway type requires Consultant's approval. Pathways shown without cable fill are for temporary or future cable use.

2.02 CONDUITS

A. General
   1. Provide Pull String in all conduits for AV system.
   2. The sizes of conduits shall be as shown on the drawings, minimum size is 0.75". All conduits shall be reamed and furnished with insulation and/or grounded bushings as required.

B. Flexible Steel Conduit
   1. Flexible steel conduits are not acceptable for AV systems installations

C. Electrical Metallic Tubing (EMT)
   1. EMT shall be zinc galvanized both inside and out with a minimum thickness of .0008". It shall be round with uniform wall thickness and continuously welded seams. EMT shall be furnished in ten-foot standard lengths.

D. PVC Conduit
   1. PVC conduit shall be rigid non-metallic Schedule 40 heavy wall.
   2. Use of PVC shall be limited to underground conduits only.

E. Conduits carrying fiber cables shall have large labels indicating "Fiber Optic Cable." These labels should be placed every 10 feet where exposed.

F. Buried conduits must have yellow “Caution Fiber Optic” tape laid 12 inches above duct bank.

2.03 PULL BOXES

A. Pull boxes shall be constructed of code gauge steel, etched, primed and shall have rust resistant ANSI 61 gray finish and be NEMA 1 construction with screw covers unless noted otherwise. For conduits 1-1/4" and larger terminating in a pull box, the minimum length of pull box shall be 8 times the diameter of the largest conduit terminating in the pull box. Splice boxes shall be sized as per EIA/TIA-569A Table 5.2-3.
B. Location and sizes of pull boxes and splice boxes shall meet the approval of the Architect and Consultant. Condulete type fittings (e.g. LB's, etc.) shall not be used in lieu of pull boxes or bends.
C. Exposed pull boxes in public areas shall be provided with tamperproof screws.
D. Boxes shall be free from unused openings, including knockouts.
E. Pull boxes larger than 12” x 12” for which a custom panel has not been specified, shall have hinged covers.
F. Gang, 4” square and 4-11/16” square boxes must be installed using open center brackets
G. Pull boxes for indoor wet or damp locations shall be NEMA 3R Rated with stainless steel screws.
H. Pull boxes for outdoor locations shall be NEMA 4X Rated stainless steel continuous hinges, door clamps and a hasp.
I. Provide junction box, pull box, and hand-hole assemblies sized as required by the NEC. Pull boxes/hand-holes shall be located using the following table:
    1. Runs with total of all bends <90 degrees – 600ft.
    2. Runs with total of all bends >=90 degrees and <180 degrees – 400ft.
    3. Runs with total of all bends >= 180 degrees and <270 degrees – 200ft.
    4. Runs with total of all bends >= 270 degrees are not allowed.

2.04 CONDUIT FITTINGS

A. All rigid, IMC and EMT fittings shall be galvanized malleable iron or steel. Connectors and couplings shall be threaded, setscrew, compression type, and concrete-tight.
B. Conduit bodies shall be malleable iron, threaded type. Provide neoprene cover gaskets for conduit body covers exposed to the weather.
C. Expansion fittings shall be O-Z/Gedney Type "AX" for rigid metal conduit and Type "TX" for electrical metallic tubing. For intermediate metal conduit applications, a 15-inch minimum length of rigid metal conduit shall be used with a Type "AX" expansion fitting. Provide O-Z/Gedney Type "BJ" bonding jumpers at all expansion fittings.
D. Rigid and IMC conduit bushings shall be of the insulated type with phenolic thermosetting insulation molded to a hot dipped galvanized malleable iron body of the threaded type.
E. EMT fittings shall be of the insulated throat type. Fittings larger than 2-1/2 inches shall have threaded bushings installed.
F. PVC conduit fittings shall be slip joint type.
G. All conduit sleeves will be fitted with “spillways” to maintain the bend radius of cables passing through the sleeve.

2.05 FLOOR BOXES

A. Refer to AV drawings for manufacturer, model, quantity, and location information.
B. Contractor to provide all parts and accessories required for a working floor box system including those required based on specific installation conditions unless otherwise noted.

C. Boxes to have a voltage divider to allow for power receptacles and low-voltage AV connections to reside within the same box. Conduits for high and low voltages must enter box on appropriate side of voltage divider to maintain separation. High and low-voltage wires may not cross within the box.
D. On-grade boxes to be cast-iron, and above grade, in-slab boxes to be steel.
E. Boxes to be fully adjustable, before and after the concrete pour.
F. Boxes shall have applicable approvals from a Nationally Recognized Testing Laboratory and meet all applicable local codes.
G. Floor Boxes on elevated floors must maintain proper fire rating of slab.
H. Provide equipment ground conductor as required by local code.

2.06 CABLE TRAY

A. Cable trays shall be installed as indicated on the AV drawings.
B. Unless otherwise noted on the Drawings, cable tray shall be 12 inches wide and have a usable minimum loading depth of 4 inches deep.
C. Industrial type, single-piece, formed aluminum trough cable tray for heavy cable loads and large cables shall be Chalfant Ladder Tray or Type 156 by B-Line, 4” usable depth and 9” rungs as indicated on the drawings. The tray shall be either trapeze or wall mounted.
D. Industrial type, single-piece, 16-ga fully welded tubular steel with 2-layer black powder coat finish with 9” rungs as indicated on the drawings.
E. Cable tray used in open ceilings in finished areas and storage rooms shall be solid bottom.
F. Straight sections shall be a maximum nominal 10-foot length.
G. Straight sections and fittings shall be assembled with nut and bolted splice plates. Hardware shall be zinc plated. Spring loaded and "snap" type fittings are not acceptable.
H. Factory end plates and fittings shall match the tray width, depth and metal type.
I. The cable tray system shall be U.L. Listed and classified with applicable U.L. labels applied. Cable tray installation shall meet all applicable UL standard requirements for use as an equipment ground conductor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General
1. Whenever possible, cable and raceway routing paths shall follow the logical structure of the building (e.g. follow hallways, aisles and corridors). Route all AV cables and raceways parallel to or perpendicular to the building structure. No diagonal runs will be permitted unless noted otherwise or pre-approved by the Architect and Consultant. Corridor crossovers shall be kept to a minimum.
2. Coordinate layout of conduits including specific routing and mounting elevations with building structure and work of other trades.
3. Provide a pull string in all raceways, cable trays and conduits.
4. Transitions between cable trays and conduit, etc. shall not exceed 10” horizontally, 24” vertically. Provide “drop-out” supports spillways, and radius controls for changes in elevation as required.
5. All power devices and power sources emit a given amount of radio frequency interference (RFI) and/or electro-magnetic interference (EMI). To reduce or eliminate the field effects of RFI/EMI on the signals residing on a given cable, runs shall be kept at the maximum possible distance from such sources. Running cables through the center of the building can reduce the external interference

effects of RFI/EMI in the cable tray. Open wiring and non-metallic raceway shall be routed a minimum of twelve (12") inches away from fluorescent fixtures. Special attention shall be given to the routing of such pathways away from lighting ballasts and high intensity discharge devices. Reference TA001 for the required separation distances of signals of different types.

B. Conduits
1. Provide continuous conduits across open or inaccessible ceiling areas. Exposed conduits shall be installed parallel and perpendicular to nearby surfaces and structural members. Exposed conduits shall be painted to match the surrounding surfaces. Coordinate color with Architect.
2. Changes from home run conduits to stub up must be approved by The Consultant.
3. Provide conduits from cable trays to accessible ceilings as required.
4. Conduits attached to cable trays shall be secured with approved conduit clamps.
5. Conduit buried in concrete slab pours shall be full weight rigid galvanized steel or Schedule 40 PVC. All elbows, stub ups and conduit above ground shall be rigid galvanized steel. All joints and terminations for PVC shall be made according to manufacturer's recommendations to ensure all joints are watertight.
6. Conduit buried in or beneath building slabs or exterior below grade shall be full weight rigid galvanized steel or Schedule 40 PVC. The conduit shall be encased in 3" concrete envelope or as called for on the Plan Drawings. All elbows and stub ups shall be rigid galvanized steel. All joints and terminations for PVC shall be made according to manufacturer's recommendations to ensure all joints are watertight.
7. Conduits and cables entering from outside the building shall be sealed water and moisture tight. Seal between conduit and sleeves, conduits and core drilled holes and around conductors inside conduits. Provide cast iron pipe or Schedule 40 galvanized steel conduit sleeves in exterior walls below grade, with intermediate wall stop and anchor collar set in place before concrete pouring. Sleeve shall be a part of the sealing assembly. When the wall opening is core drilled, the wall sleeve may be omitted. A mechanically compressed rubber sealing assembly shall be placed in the annular space between conduit and the sleeve or the core drilling.
8. Conduits stubbed out into accessible ceiling to be located no more than 2’-6” above finished ceiling.
9. All conduit stub-outs and junction boxes in accessible ceilings to remain accessible by ladders from the finished floor below.
10. Layout the conduit system to avoid crossing building expansion joints. Where crossings are necessary, use expansion joints.

C. Boxes
1. Wall or ceiling boxes must be mounted flush with finished surface.
2. Final mounting height of all boxes on finished surfaces to be coordinated with Architect for alignment with adjacent boxes.
3. In stud walls, boxes on opposite sides of the wall must be separated by a minimum of 1 stud cavity.
4. In CMU or concrete walls, boxes on opposite sides of the wall must be separated by a minimum of 16”.
5. Pull boxes shall be placed in straight sections of conduit runs and may not be used in lieu of a bend without approval of the Consultant. Pull boxes and/or splice boxes shall be installed in readily accessible locations. Where boxes are installed above suspended ceilings, they shall be located immediately above the suspended ceiling or the ceiling shall have a suitably marked and hinged panel to facilitate direct access to the pull box.
6. Boxes in accessible ceiling to be located no more than 2’-6” above finished ceiling.
7. All boxes mounted in accessible drop tile ceilings to remain accessible by ladders from the finished floor below.

D. Cable Tray
   1. Cable trays shall be trapeze hung and sway braced.
   2. Cable trays will not be permitted in FOH public areas, mechanical rooms, electrical rooms or any wet or damp rooms. In these area conduits are required.
   3. All changes in elevation of the cable tray or where cable leaves the cable tray factory produced radius drop offs, waterfalls and other devices shall be used to ensure the proper cable bend radius is maintained.
   4. When rated walls must be breached, cables shall pass through pre-established fire block systems by EZ-Path or similar. Multiple systems shall be used to equal the full capacity of the cable tray. Cables shall enter and/or exit areas at right angles to the structure.

E. Fire Stopping
   1. Where pathways pierce walls, floors and/or ceilings, restore fire rating and smoke stoppage integrity as required by code.

F. Excavation:
   1. It is the responsibility of the Contractor to obtain all permits and utility marking. Bids shall include landscaping restoration costs.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Raceways and Fittings

B. Polymer Handhole Enclosures

C. Pre-Cast Concrete Handholes and Boxes

D. Pre-Cast Maintenance Holes

E. Utility Structure Accessories

F. Equipment Enclosures for Exterior Spaces

G. Grounding and Bonding

1.02 RELATED REQUIREMENTS

A. General provisions of the Contract, including General and Supplementary Conditions and Division 01, 07, 31 and 32 Specification Sections.

B. Section 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

C. Section 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

D. Section 27 0010 - GENERAL COMMUNICATIONS REQUIREMENTS

E. Section 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

F. Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

1.03 ABBREVIATIONS AND ACRONYMS

A. See Section 27 0010 - GENERAL COMMUNICATIONS REQUIREMENTS for additional abbreviations and acronyms that pertain to this section.

B. GRS: Galvanized Rigid Steel Conduit

C. RMC: Rigid Metal Conduit

D. RNC: Rigid Nonmetallic Conduit

1.04 DEFINITIONS

A. See Definitions in Part 1 of 27 0010 - GENERAL COMMUNICATIONS REQUIREMENTS for additional definitions that pertain to this section.

1.05 REFERENCE STANDARDS

A. 7 CFR 1755.910 (PE-91) - RUS specification for outside plant housings and serving area interface systems; Current Edition.

B. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

C. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.

D. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

E. ASTM B187 - Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes; 02.01.

F. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).

G. ASTM B30 - Standard Specification for Copper Alloys in Ingot Form; latest revision.

H. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

I. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

J. ASTM C305 - Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency; 2020.

K. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2019.

L. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures; 2019.

M. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2020.

N. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.

O. ASTM D570 - Standard Test Method for Water Absorption of Plastics; 2022.

P. ASTM D2444 - Standard Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight); Feb 23, 2021.

Q. ASTM E432 - Standard Guide for Selection of a Leak Testing Method; 2011.

R. ASTM G154 - Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials; 2023.

S. BICSI OSPDRM - BICSI Outside Plant Design Reference Manual; Current Edition.

T. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

U. IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding; 2014.

V. ISO 10012 - Measurement management systems — Requirements for measurement processes and measuring equipment; 2003.

W. ISO 9000 - Quality Management Systems -- Fundamentals and Vocabulary; 2015.

X. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

Y. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.

Z. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

AA. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

BB. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

CC. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.

DD. UL (DIR) - Online Certifications Directory; Current Edition.

EE. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

FF. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

GG. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

HH. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

1.06 SUBMITTALS

A. See Section 27 0010 - GENERAL COMMUNICATIONS REQUIREMENTS, for submittal procedures.

B. Pre-construction submittal

1. Product data

a) Raceways, Raceway fittings, separators, and accessories, duct-bank materials, manholes/handholes, solvent cement, sealants, tracer wire, warning tape / warning planks.

2. Shop drawings

a) Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.

b) Detailing of pathway and placement of manhole/handhole devices for underground duct bank pathways.

C. Project completion submittal

1. Accurately record actual routing of exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements for all components of the pathway (duct bank sizing and location, conduit quantities and placement within the duct bank, tracer wire locations and sizing, warning plank location and sizing, manhole/handhole placement as well as sizing of each manhole/handhole installed).

1.07 QUALITY ASSURANCE

A. Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification.

B. Materials shall be manufactured by companies specializing in the products specified in this Section, for a minimum of 5 years.

C. Communications and Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and is acceptable to AHJ.

2. Marked for intended use.

D. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gauges shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards

E. Refer to Section 27 0010 - GENERAL COMMUNICATIONS REQUIREMENTS for additional Quality Assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.

B. Store pre-cast and other factory-fabricated underground utility structures at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.

C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.09 FIELD CONDITIONS

A. Interruption of existing communications services to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical and communications services according to requirements indicated.

1. Notify Contract Administrator no fewer than two weeks in advance of proposed interruption of the electrical or communications services.

2. Coordinate service interruptions with the other trades, customer AHJ and architectural team.

a) Confirmation of the interruption shall be confirmed with a signed notice from the above-mentioned parties.

1.10 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with ranking or preference.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 RACEWAYS AND FITTINGS

A. Metal Conduit

1. Manufacturers:

a) AFC Cable Systems, Inc.

b) Alflex Corporation, a Southwire Company

c) Anamet Electrical, Inc.; Anaconda Metal Hose.

d) Electri-Flex Co.

e) Indalex

f) Manhattan/CDT/Cole-Flex

g) O-Z/Gedney; Unit of General Signal (Fittings)

h) Republic Raceway

i) Tyco International; Allied Tube & Conduit Div.

j) Wheatland Tube Co.

k) Or approved equivalent

2. RMC:

a) GRS: Hot-dip galvanized steel (including threads): ANSI C80.1, UL 6

b) Plastic-Coated GRS and Fittings: NEMA RN 1, UL listed. Coating thickness of 0.40 inches (1 mm), minimum.

c) Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

a) AFC Cable Systems, Inc.

b) American International.

c) Anamet Electrical, Inc.; Anaconda Metal Hose.

d) Arnco Corp.

e) Cantex Inc.

f) Certainteed Corp.; Pipe & Plastics Group.

g) Condux International.

h) ElecSYS, Inc.

i) Electri-Flex Co.

j) Lamson & Sessions; Carlon Electrical Products.

k) Manhattan/CDT/Cole-Flex.

l) RACO; Division of Hubbell, Inc.

m) Spiralduct, Inc./AFC Cable Systems, Inc.

n) Superflex Ltd.

o) Thomas & Betts Corporation.

2. RNC: Extra-heavy Schedule 80 conduit type EPC-80-PVC, PVC: NEMA TC 2, NEMA TC 6&8, UL 651.

a) Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6&8, UL 651, as applicable and UL listed for direct burial as well as above ground use.

3. RNC: Heavy Schedule 40 conduit type EPC-40-PVC, PVC: NEMA TC 2, UL 651.

a) Fittings: match to raceway type and material: NEMA TC 3, NEMA BI 50063, UL 651, as applicable and UL listed for direct burial as well as above ground use.

C. Duct Accessories

1. Innerduct

a) Install size and quantity of innerduct within conduits as identified on the drawings.

b) Requirements:

1) Suitable for installation within the installed conduits

2) Sequential foot markings

3) Material shall be corrugated High Density Polyethylene (HDPE)

4) Manufacturer shall be: Duraline Corrugated, or approved equivalent.

5) Material shall be polyester/nylon textile containing 1250 lb polyester flat woven pull tape.

6) Manufacturer shall be: Maxcell ____

2. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.

3. Underground-line warning tape / tracer wire:

a) Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1) Not less than 6 inches wide by 4 mils thick.

2) Compounded for permanent direct-burial service.

3) Embedded continuous metallic strip or core.

4) Printed legend shall indicate type of underground line.

4. Concrete warning planks (to be installed over direct-buried duct-banks) shall be nominal 12 inches by 24 inches by 3 inches in size, manufactured from 6000 psi concrete.

a) Color: Red dye added to concrete during batching.

b) Labeling: Mark each plank with “COMMUNICATIONS” in 2 inches high, 3/8 inch deep letters.

5. Refer to details on drawings for additional accessories.

D. MicroDuct

1. Products

a) Manufacturers:

1) Clearfield

2) Duraline

3) Hexatronic

4) Sumitomo Electric Lightwave

2. Description

a) Configuration: See Drawings

b) MicroDuct OD: See Drawings

c) Colors: Orange

d) Fittings: Micro Couplers, Micro End Caps, Splice Kits, Mounting Bracket, Gas Block Connector, Enclosure Connector, Distribution Box, and Silicone Lubricant

e) Options: None

2.03 POLYMER HANDHOLE ENCLOSURES

A. General

1. Products

a) Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers.

b) Manufacturers:

1) Hubbell Power Systems, Inc. / Quazite

2) Oldcastle Pre-cast Group

2. Requirements

a) Comply with

1) UL (DIR)-Listed per SCTE 77

2) ASTM G154

3) RUS 7 CFR 1755.910 (PE-91)

4) ASTM D543

5) ASTM D570

6) ASTM D2444

b) Available materials

1) Polyolefin Blend

2) Aggregate combined with polymer resin and reinforced with fiberglass.

3) Fiberglass reinforced polymer (FRP)

4) Structural foam molded high density polyethene (HDPE)

c) Boxes

1) Wall Style: Straight Wall

2) Bottom Type: Open Bottom

3) Other requirements: Mousehole knockouts, Dividers, Box Collars, Pulling Eye, Cable Rack, and Ground Buss

d) Covers

1) The cover shall have “COMMUNICATIONS” molded into the cover.

2) Color: no preference

3) Bolts: LockDown LockOut(tm) Bolts

2.04 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers.

2. Manufacturers:

a) Carder Concrete Products.

b) Christy Concrete Products

c) Elmhurst-Chicago Stone Co.

d) Oldcastle Pre-cast Group

e) Riverton Concrete Products; a division of Cretex Companies, Inc.

f) Utility Concrete Products, LLC

g) Utility Vault Co.

h) Wausau Title, Inc.

i) Or Approved Equivalent

B. Comply with ASTM C858 for design and manufacturing process.

C. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

a) Cover Hinges: Concealed, with hold-open ratchet assembly.

b) Cover Handle: Recessed.

4. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.

5. The cover shall have the following legend lettering molded into the cover:

a) “COMMUNICATIONS” for communications spaces

6. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

7. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.

   a) Extension shall provide increased depth of 12 inches.

   b) Slab shall be same dimensions as bottom of enclosure and arranged to provide closure.

8. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

   a) Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.

   b) Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.

   c) Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

9. Duct entrances into handhole walls shall have cast end-bell or duct-terminating fittings in the wall for each entering duct.

   a) Type and size shall match fittings to duct or conduit to be terminated.

   b) Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

   c) Rigid steel conduits shall be hot-dipped galvanized malleable iron or steel threaded to the end if the conduit is cast in place in the wall of the manhole.

10. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

11. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12 inches of top and between wall-mounted cable racks. Length shall be sufficient to attach to ground rod that stubs up 4 inches through manhole/handhole floor. Refer to detail on drawings and BICSI OSPDRM for more information.

2.05 PRE-CAST MAINTENANCE HOLES

A. Pre-cast-concrete manholes shall be furnished in sizes as indicated on the plans and as specified herein. Pre-cast manholes shall be constructed of reinforced concrete with a minimum 28-day concrete compressive strength for concrete at 4000 psi (min). Concrete used in the construction of the manhole shall contain

steel reinforcing bars to conform to applicable building codes. Reinforcing steel shall conform to ASTM E432 and ASTM C305.

B. Manholes shall be provided complete with appurtenances and accessories required.

1. Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers.

2. Manufacturers: Subject to compliance with requirements and hold a current NPCA certification, provide products by one of the following:

a) Barbour Concretes.

b) PreTech Corp.

c) Precision Precast Co.

d) Oldcastle Pre-cast Group.

e) Utility Concrete Products, LLC.

3. Substitution of Other Manufacturers: Subject to compliance with requirements; pre-caster shall hold a current NPCA certification. Requests to utilize an alternate pre-cast manufacturer shall be provided in writing and approved by Design Consultant prior to procurement and implementation.

C. Comply with ASTM C478 and with interlocking mating sections, complete with accessories, hardware, and features.

D. Windows: Pre-cast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Windows shall be located no less than 6 inches form interior surfaces of walls, floors, or roofs of manholes, but close enough to facilitate racking of cables on walls.

2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.

3. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

4. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.

E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.

2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

3. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.

F. Concrete Knockout Panels: 1-1/2 inches to 32 inches thick, for future conduit entrance and sleeve for ground rod.

G. Each manhole shall provide a sump drywell of at least 8 inches in diameter.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

I. Bonding Ribbon

1. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12 inches of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4 inches through manhole/handhole floor. Refer to BICSI OSPDRM for more information.

2.06 UTILITY STRUCTURE ACCESSORIES

A. Utility structures shall be installed complete including accessories as listed below.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a) Elmhurst-Chicago Stone Co.

b) McKinley Iron Works, Inc.

c) Neenah Foundry Company.

d) NewBasis

e) Oldcastle Precast Group

f) Osburn Associates, Inc.

g) Pennsylvania Insert Corporation.

h) Precision Precast

i) PreTech Corp

j) Riverton concrete Products; a division of Cretex Companies, Inc.

k) Strongwell Corporation; Lenoir City Division.

l) Underground Devices, Inc.

m) Utility Vault Co.

n) Wausau Tile, Inc

o) Or Approved Equivalent

2. Contractor shall provide cut sheets and engineered shop drawings for the manhole for review and approval prior to procurement and installation.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 32 inches; cover to be rated for heavy traffic H-20, UON.

a) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b) Special Covers: recess in face of cover designed to accept finish material in paved areas

c) For MV 12 feet to 20 feet in length two (2) covers shall be provided; for MV over 20 feet three (3) covers shall be provided.

2. Cover Legend: Cast in. Selected to suit system.

a) "COMMUNICATIONS"

3. Manhole Chimney Components: Pre-cast concrete rings with dimensions matching to those of roof opening.

a) Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387/C387M, Type M, may be used. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

4. Pulling Irons in Concrete Walls:

a) Locate centrally over conduit ingress/egress locations: manufactured by Cooper Power Systems, Joslyn Manufacturing and Supply, Hubbell / Chance, or pre-approved equal. Devices shall be 7/8 inch in diameter with a length of 12 inches and a width of 10-7/8 inch; irons shall be embedded within the walls with a max tension of 13,000 lbf.

C. Pulling-In and Lifting Irons in Concrete Floors: 7/8 inch diameter, hot-dip galvanized, bent rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000 lbf shear and 60,000 lbf tension

D. Bolting Inserts for concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of non-corrosive, chemical-resistant, non-conductive thermoplastic material; 1/2 inch ID by 2-3/4 inch deep, flared to 1-1/4 inch minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

E. Expansion Anchors for Installation after Concrete is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2 inch bolt, 5,300 lbf rated pullout strength, and minimum 6,800 lbf rated shear strength.

F. Cable Rack Assembly: Stainless Steel stanchions and Non-metallic arms. Components fabricated from nonconductive, fiberglass-reinforced polymer.

G. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

H. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

I. Cover Hooks: Heavy duty, design for lifts 60 lbf and greater; two required, to be deliverd to the Owner prior to Substantial Completion.

J. Security: Secure access to utility structures. Provide LockDown, Inc. or McGard, LLC

2.07 EQUIPMENT ENCLOSURES FOR EXTERIOR SPACES

A. Refer to Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS for information.

2.08 GROUNDING

A. Ground Rods: UL-listed:

1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
2. 3/4 inch thick, by 10 ft long
3. Manufacturer shall be:
    a) Copperweld Steel Company
    b) ITT Weaver
    c) Thomas & Betts
    d) Pre-Approved equal.

B. Grounding Conductors and Connectors

1. Manufacturers:
    a) Apache Grounding/Erico Inc.

b) Boggs, Inc.

c) Chance/Hubbell.

d) Copperweld Corp.

e) Dossert Corp.

f) Erico Inc.; Electrical Products Group.

g) FCI/Burndy Electrical.

h) Galvan Industries, Inc.

i) Harger Lightning Protection, Inc.

j) Hastings Fiber Glass Products, Inc.

k) Heary Brothers Lightning Protection Co.

l) Ideal Industries, Inc.

m) ILSCO.

n) Kearney/Cooper Power Systems.

o) Korns: C. C. Korns Co.; Division of Robroy Industries.

p) Lightning Master Corp.

q) Lyncole XIT Grounding.

r) O-Z/Gedney Co.; a business of the EGS Electrical Group.

s) Panduit, Inc

t) Raco, Inc.; Division of Hubbell.

u) Robbins Lightning, Inc.

v) Salisbury: W. H. Salisbury & Co.

w) Superior Grounding Systems, Inc.

x) Thomas & Betts, Electrical.

y) Or approved equivalent

2. Grounding Conductors

a) Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.

b) Underground Conductors: Tinned-copper conductor, No. 2/0 AWG minimum stranded, unless otherwise indicated.

c) Bare Copper Conductors: Comply with the following:

1) Solid Conductors: ASTM B3.

2) Assembly of Stranded Conductors: ASTM B8.

3) Tinned Conductors: ASTM B33.

d) Copper Bonding Conductors

1) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.

2) Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

3) Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

3. Connector Products

a) Comply with IEEE 837 UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

b) Bolted Connectors: Bolted-pressure-type connectors

1) Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM B187, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

(a) Company symbol and/or logo.

(b) Catalog number.

(c) Conductors accommodated.

(d) Installation die index number or die catalog number is required.

(e) Underwriters Laboratories “Listing Mark:”.

(f) The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL 467.

2) Cast connectors: copper base alloy according to ASTM B30.

c) Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL

1. Install in accordance with manufacturer's instructions.

2. Refer to Section 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS for additional

requirements. Where conflict exists, the more stringent requirements shall apply.

B. UNDERGROUND DUCT APPLICATION

1. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80 PVC, in concrete-encased or direct-buried duct bank, unless otherwise indicated.

   a) For changes in elevation or direction, conduit shall be RMC or concrete-encased PVC.

2. Underground Ducts Crossing Paved Paths, Walks, and Driveways, Roadways, and Railroads: RNC, NEMA TC 2 Type EPC-80 PVC, encased in reinforced concrete.

C. UNDERGROUND ENCLOSURE INSTALLATION

1. Handholes and boxes Telephone, Communications, and Data Wiring:

   a) Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB H-20 structural load rating.

   b) Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.

   c) Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.

   d) Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000 lbf vertical loading.

   e) Handholes shall be used as pull-through points only. Handholes shall not be used as splice points.

   f) Handholes shall not be used in conduit runs that have more than (3) three 4 inch conduits.

   g) Joint use of handholes by other trades is not allowed.

2. Maintenance holes: Pre-cast concrete.

   a) Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

   b) Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

D. EARTHWORK

1. Excavation and Backfilling: Comply with Section 31200 Earth Moving, but do not use heavy-duty, hydraulic-operated, compaction equipment.

2. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.

3. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329000 Planting.

4. Cut and patch existing pavement in the path of underground ducts and utility structures according to Section 03 0100 - Maintenance of Concrete.

E. DUCT INSTALLATION

1. Maintain a minimum trench depth to allow for the top row of conduits in the duct bank to be 36 inch below grade.

2. Contractor shall remove rock and debris from backfill material. Contractor shall remove excess material from the site and compact the excavation. Unpaved areas shall be finished flush with the surrounding natural ground. Contractor shall restore damaged grassed areas.

3. Contractor shall tamp backfill material in 6 inch lifts with a mechanical tamp until compact density is at least equal to surrounding density

4. For concrete and driveway approaches, Contractor shall replace the entire joint of the approach unless otherwise directed by the Design Consultant. In areas with brick sidewalks, remove only the existing brick pavers necessary to install the conduit. Replace the brick pavers within seven (7) days of their removal. Furnish new bricks of similar type necessary to restore sidewalk area to its original appearance. New bricks shall identically match the existing brick pavers.

5. Contractor shall backfill the trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided causing a deviation in the elevation height of the multi-duct conduit system. The purpose of the backfill is to provide a gradual change in elevation of the trench, from the bottom to the highest point of the obstruction such that excessive bending and stress will not be transferred to the conduits once the conduit system is installed.

6. Slope: Pitch ducts a minimum slope of one-half percent down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

7. All underground conduits shall be slurry capped sealed.

8. Conduit lengths shall contain no continuous sections longer than 300 feet. If conduit lengths total more than 300 feet, pull points (manholes / handholes) shall be provided. The use of pull boxes to changes directions is prohibited, unless expressly detailed or indicated on the drawings.

9. Conduits shall have no more than 180 degrees of cumulative bends between pull points or more than 90 degrees of bends at any one point. Bends shall be long, sweeping bends with a radius of not less than six times the internal diameter of conduits 2 inches or smaller, or ten times the internal diameter of conduits larger than 2 inches. 48 inches sweeps are preferred.

    a) For changes in elevation or direction conduit shall change to RMC from PVC.

10. Required separation from other utilities.

    a) Power up to 1KVA:

        1) 12 inches of well-packed earth

        2) 4 inches of masonry

        3) 3 inches of concrete

    b) Gas, Oil, Water, etc.:

        1) 12 inches when parallel

        2) 6 inches when crossing

11. All conduits shall be mandrelled prior to installation of cable or (for spare conduits) prior to substantial completion; the OD of the test mandrel shall be no smaller than 80% of the conduit internal diameter.

12. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

13. Duct Entrances to Manholes and Handholes: Use end bells, spaced approximately 10 inches on center for 4 inches ducts, and vary proportionately for other duct sizes.

    a) Begin change from regular spacing to end-bell spacing 10 ft from the end bell without reducing duct line slope and without forming a trap in the line.

    b) Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in disturbed earth adjacent to manhole or handhole.

    c) Grout end bells into structure walls from both sides to provide watertight entrances.

    d) Ends of conduits shall be reamed.

    e) Conduits in the telecommunications duct bank shall enter one end of the manhole / handhole and exit the opposite end, UON.

14. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 ft outside the building wall without reducing duct line slope away from the building, and without forming a trap in the

line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 05 00 - Common Work Results for Electrical.

15. All conduits entering a building shall be pitched to drain away from the building to avert water intrusion. To prevent conduit shearing, conduits entering through walls shall be RMC and extend to undisturbed earth, particularly where such backfill is susceptible to load bearing tension.

16. Sealing: Provide temporary closure at termination of ducts that enter buildings. After cable installation, seal ducts (including spare) at termination.

17. Pulling Cord: Install 1250 lbf 1/2 inch (min) wide mule tape in conduits and in innerducts installed, including spares; mule tape shall provide footage markers and be indexed to facilitate future identification.

18. Concrete-Encased Ducts: Support ducts on duct separators.

    a) Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft of duct. Spacers shall be installed / utilized per the manufacturer's standard specifications. Couplings for conduits shall be staggered at least 6 inch. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6 inch between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.

    b) Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

        1) Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.

        2) If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4 inch reinforcing rod dowels 18 inch into concrete on both sides of joint near corners of envelope.

    c) Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise in middle, uniformly filling open spaces. Do not use

power-driven agitating equipment unless specifically designed for duct bank application.

d) Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

e) Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

f) Minimum Space between Ducts: 3 inch between ducts and exterior envelope wall, 2 inch between ducts for like services, and 4 inch between power and signal ducts.

g) Depth: Install top of duct bank at least 24 inch below finished grade in areas not subject to deliberate traffic, and at least 30 inch below finished grade in deliberate traffic paths of vehicles, unless otherwise indicated.

h) Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

1) Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inch of concrete.

2) Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inch from edge of base. Install insulated grounding bushings on terminations at equipment.

i) Warning Tape: Bury warning tape approximately 18 inch above concrete-encased ducts and duct banks. Align tape parallel to and within 3 inch of the centerline of duct bank. Provide an additional warning tape for each 12 inch increment of duct-bank width over a nominal 18 inch. Space additional tapes 12 inch apart, horizontally

j) Tracer Wire: Provide an orange #8 AWG high strength copper clad steel with a high-density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8 ft with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the dumber of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application if an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

19. Direct-Buried Duct Banks:

a) Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

b) Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.

c) Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as Specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.

d) Install backfill as Specified in Division 31 Section "Earth Moving".

e) After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inch over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".

f) Install ducts with a minimum of 3 inch between ducts for like services and 6 inch between power and signal ducts, unless more restrictive separation is specified elsewhere in this section or on the drawings.

g) Depth: Install top of duct bank at least 36 inch below finished grade, unless otherwise indicated.

h) Set elevation of bottom of duct bank below the frost line.

i) Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   1) Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inch of concrete.

   2) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inch from edge of base. Install insulated grounding bushings on terminations at equipment.

j) Warning Planks: Bury warning planks approximately 18 inch above direct-buried ducts and duct banks placing them 24 inch on center. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12 inch increment of duct bank width over a nominal 18 inch. Space additional planks 12 inch apart, horizontally.

k) Tracer Wire: Provide an orange #8 AWG high strength copper clad steel with a high-density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8 ft with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the dumber of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application if an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

F. TEXTILE INNERDUCT INSTALLATION

1. Manufacturer may provide on-site installation assistance free of charge to Contractors unfamiliar with product. Use of this service is highly encouraged. Contact Maxcell at 888-387-3828 to find closest Territory Manager.

2. Provide textile innerduct in conduit using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.

3. Make a 2 inch incision, approximately 18 inch from the end of textile innerduct. Pull out and cut off approximately 24 inch of pull-tape. Thus allowing the pull tape ends to retract back into the cells.

4. Using approximately 6 ft of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over knots and the end of textile innerduct. Using a Bow Line knot tie a swivel to the end of 3 ft pull tape. For multi-pack installations one swivel is sufficient but stagger each textile innerduct.

5. Using a bow line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct - ensuring that no twist is introduced to the innerduct.

6. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.

7. Textile Innerduct Mountings, Hangers, and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.

8. Maintenance Hole and Hand Hole Installation:

a) At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.

b) At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

9. Penetrations

   a) Seal conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids, or rodents.

G. INSTALLATION OF CONCRETE MAINTENANCE HOLES, HANDHOLES, AND BOXES

1. Precast Concrete Handhole and Manhole Installation

   a) Comply with ASTM C891, unless otherwise indicated.

   b) Install each unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

2. Elevations

   a) Install manholes / handholes per manufacturer's instructions; lid to manhole / handhole to be flush with the surrounding terrain so that no earth, roadway, or sidewalk removal is required to access the manhole / handhole interior. Contractor to provide chimney/ extensions / collars to facilitate the placement of the manholes / handholes to maintain the minimum distance to the surface above the highest row of conduits in the duct bank given the location of the manhole / handhole at the point of installation.

   b) Maintenance hole Roof: Install with rooftop at least 15 inch below finished grade.

   c) Install handholes with bottom below the frost line, 36" minimum below grade.

   d) Handhole Covers: Set surface flush with finished grade.

3. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

4. Manhole Access: Circular opening in manhole roof; sized to match cover size.

   a) Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

   b) Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

5. Waterproofing: Apply waterproofing to exterior surfaces of maintenance holes and hand holes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastromeric Sheet Waterproofing". After ducts have been connected and grouted, and before backfilling, waterproof joints and

connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days

6. Dampproofing: Apply dampproofing to exterior surfaces of maintenance holes and hand holes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing". After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

7. Hardware: Install removable hardware, including pulling eye, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.

8. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in maintenance holes.

9. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inch for manholes and 2 inch for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

10. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover

H. GROUNDING

1. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inch above to 6 inch below concrete. Seal floor opening with waterproof, nonshrink grout.

2. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3. Equipment Grounding Conductors

   a) Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

b) Underground Grounding Conductors: Bury at least 24 inch below grade, or 6 inch below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inch above duct bank.

4. Connections

a) General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

1) Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2) Make connections with clean, bare metal at points of contact.

3) Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4) Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5) Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

b) Compression Fittings: Permanent compression-type fittings may be used for the following:

1) Connecting conductors together.

2) Connecting conductors to ground rods

c) Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

d) Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector is adequately compressed on grounding conductor.

e) Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area

of connection and seal against moisture penetration of insulation and cable.

5. Field Quality Control

a) Testing: Perform the following field quality-control testing:

1) Test completed grounding system at each location. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

2) Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3) Perform point-to-point megohmmeter tests between the ground rod and cable shields, splice cases, locate wires, and racking hardware to determine the resistance.

4) Investigate point-to-point resistance values that exceed 0.5 ohms.

(a) Check for loose connections.

(b) Check for absent or broken connections.

(c) Check for poor quality welds.

(d) Consider other reasons.

5) Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

I. GRADING AND PLANTING

1. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

3.02 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

END OF SECTION

SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Multimode optical fiber cabling
2. Single mode optical fiber cabling

B. Related Requirements:

1. Section 27 05 26 – Grounding and Bonding for Communications Systems
2. Section 27 05 53 – Identification for Communications Systems
3. Section 27 11 19 – Communications Termination Blocks and Patch Panels
4. Section 27 16 19 – Communications Patch Cords, Station Cords, and Cross Connect Wire

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. dB – Decibel
2. ID - Identification
3. I/O - Indoor/Outdoor
4. LED – Light Emitting Diode
5. nm – Nanometer
6. OFCP – Optical Fiber Conductive Plenum
7. OFNP – Optical Fiber Nonconductive Plenum
8. OLTS – Optical Loss Test Set
9. OM – Optical Fiber, Multimode
10. OS – Optical Fiber, Single mode

B. Reference Standards:

1. ANSI/TIA-526-7-A, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
2. ANSI/TIA-526-14-A, Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
3. ANSI/TIA-568.0-E, Generic Telecommunications Cabling for Customer Premises
4. ANSI/TIA-568.1-E, Commercial Building Telecommunications Infrastructure Standard
5. ANSI/TIA-568.3-D, Optical Fiber Cabling and Components
6. ANSI/TIA-568.3-D-1, Optical Fiber Cabling and Components – Addendum 1: General Updates
7. BICSI TDMM, 14th edition
8. NECA/FOA 301-2016, Standard for Installing and Testing Fiber Optics
9. NFPA 70®, National Electrical Code® (NEC) (currently adopted edition)
10. TIA-455-78, Revision C – IEC-60793-1-40 Optical Fibres – Part 1-40: Measurement Methods and Test Procedures - Attenuation

11. TIA-492AAAD – Detail specification for 850-nm Laser-Optimized, 50m Core Diameter/125m Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber
12. TIA-492CAAB – Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak

1.03 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.04 ACTION SUBMITTALS

A. Product Data:

1. Submit product data in .pdf format for review no later than 60 days before beginning work.

a. Optical fiber backbone cabling

B. Shop Drawings: (Not used)
C. See Section 27 05 00 – Common Work Results for Communications, for submission requirements

1.05 INFORMATIONAL SUBMITTALS

A. See Section 27 05 00 – Common Work Results for Communications, for additional information
B. Loss budget:

1. Submit link loss budget for each optical fiber backbone cable before beginning work.

1.06 CLOSEOUT SUBMITTALS

A. Format:

1. See Section 27 05 00 – Common Work Results for Communications, for additional information

B. Warranty Documentation:

1. Submit authorized cable manufacturer warranty certificate stating the terms of the cable warranty.

C. Record Documentation: (Not used)
D. Test Reports:

1. Submit test reports in .pdf format as well as in the format native to the tester. Provide tester software if not readily available for the tester manufacturer website.
2. Test reports can be delivered electronically or on electronic media. Hard copy test reports are not required.
3. Test results shall be 100 percent complete and 100 percent passing.
4. Submitting test results that fail due to length is not permitted and will not be accepted.
5. Failure to provide test reports as requested may result in the hiring of an outside testing firm to complete testing at the Contractor’s expense.
6. Submit test results in sequential order, starting at the beginning of each patch panel and working through to the last patch panel. Test results submitted out of order will be rejected.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. Installers:

a. The project requires manufacturer-certified installers experienced in optical fiber installation, splicing, and testing.

PART 2 - PRODUCTS

2.01 COMPONENTS

A. Manufacturers:

1. 24 strand OM4 I/O OFNP:

a. Belden (FD4D024P9A)
b. Berk-Tek (PDP024FB3010/F5-I/O)
c. CommScope (P-024-OD-5K-FSUBK)
d. Corning (
e. General Cable (BL0241ANU)
f. Hubbell (HFCD14024P4BK)
g. Optical Cable Corporation (DX024KALE9QP)
h. Superior Essex (W4024PK01)

2. 24 strand OS2 I/O OFNP:

a. Belden (FDSD024P9)
b. Berk-Tek (PDP024AB0707-I/O)
c. CommScope (P-024-OD-8W-FSUBK)
d. Corning (
e. General Cable (AP0241ANU)
f. Hubbell (HFCD14024PSBK)
g. Optical Cable Corporation (DX024KSLA9YP)
h. Superior Essex (W4024KK01)

3. Substitutions: Submit for approval per Section 27 05 00 – Common Work Results for Communications

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Verify pathways are complete and free of obstructions before installing cable.

3.02 INSTALLATION

A. Systems Integration:

1. Install backbone cabling in a star topology from the MDF to each IDF.
2. Calculate link loss budget to determine the total loss for each optical fiber link.
3. Do not exceed the bend radius for optical fiber cable of 20 times the outside diameter.
4. Do not exceed the pulling tension for optical fiber cable of 300 pound-force.
5. Install backbone cabling in a neat and professional manner.
6. Avoid abrasion and other damage to cable during installation. Cable found to be damaged or deformed shall immediately be replaced without additional expense.
7. Use correct environmentally rated cable for each cable. Install indoor/outdoor rated cable for wet locations.
8. Tie wraps are not permitted for cable dressing. Only hook-and-loop fasteners are permitted. Install hook-and-loop fasteners snugly without deforming the cable jacket.
9. Provide a minimum of 20 feet of slack cable in the MDF and each IDF.
10. Bond OFCP cable to the nearest bonding busbar.

3.03 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

1. Tests:

a. Test optical fiber to a minimum of Tier 1 certification according to ANSI/TIA-568.3-D-1 and TIA-455-78. Verify testing parameters with the optical fiber manufacturer before testing to meet warranty requirements.
b. Acclimate the tester to the project site before testing.
c. Testers shall be referenced using the one-jumper method with the appropriate Test Reference Cords. Multimode Test Reference Cords shall measure a maximum loss of .15 dB. Single mode Test Reference Cords shall measure a maximum loss of .20 dB.
d. A new reference shall be set if the Test Reference Cords become disconnected from the tester.
e. Multimode optical fiber cable shall be tested with an LED source and Encircled Flux compliant Test Reference Cords.
f. Optical fiber backbone cable shall have loss no greater than was provided in the link loss budget. OM4 loss shall be no greater than 3.0dB per kilometer at 850 nm and 1.5 dB per kilometer at 1300 nm. OS2 loss shall be no greater than 1.0 dB per kilometer at 1310 nm and 1550 nm.
g. When testing, label each strand as the color and backbone being tested.
h. Optical fiber backbone cable shall be terminated on fusion-splice LC cassettes only. Other means of termination will not be accepted and will be replaced at no additional cost.
i. Tester shall have been factory calibrated within 1 year of the date of testing. Test results with outdated calibration will not be accepted.
j. Enter manufacturer cable type into the tester. Test results using a cable type different than what was installed will not be accepted and shall be retested with the correct cable type at no additional cost.
k. Test results shall have project name, cable ID, date and time of test, headroom, loss/margin, manufacturer cable type and test limit, cable length, reference in dBm, number of adapters, number of splices, connector type, patch length, date and time of reference, reference type, operator name, calibration date, model name, and serial number for each test. Discrepancies shall be corrected immediately without additional cost.

l. Test results shall verify a “PASS” on each strand and display the specified parameters, comparing test values with standards-based templates integral to the testing unit. “FAIL” results are unacceptable and will require retesting until “PASS” status is achieved at no additional cost to the Owner.
m. Submit test results with passing results only. Test results submitted with failing results or negative “PASS” values will immediately be rejected.
n. In the event of unsatisfactory test results, make adjustments, replacements, or changes and repeat the tests until they are deemed satisfactory by the Owner or Consultant at no additional cost.
o. Maintain clean connector faces at all times. Clean optical fiber cassette faces before substantial completion.
p. Provide connector end face pictures upon request.
q. Approved cable tester manufacturers (OLTS):

1) AEM (TestPro CV100)
2) Fluke (CertiFiber® Pro)
3) Softing (WireXpert)
4) Trend Networks (Fibertek IV)
5) Viavi (SmartClass & Certifier40G OLTS)

2. Inspections:

a. Inspection of the cabling for correct installation, terminations, and testing is the responsibility of the Project Manager.
b. The Owner, Architect, or Consultant may elect to verify data as part of the acceptance procedure. Provide personnel and equipment at no additional cost to the Owner.

END OF SECTION 27 13 23

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. System Description

B. Active Infrastructure

1. Bi-Directional Amplifier (BDA)
2. Uninterruptible Power Supplies (UPS)

C. Passive Infrastructure

1. Antennas
2. Coaxial Infrastructure
3. Pathway Survivability

D. Remote Annunciator

E. Section 01 3000 - Administrative Requirements

F. Section 01 6000 - Product Requirements

G. Section 07 8400 - Firestopping

H. Section 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

I. Section 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

J. Section 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

K. Section 28 3111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

1.02 ABBREVIATIONS AND ACRONYMS

A. AHJ: Authority Having Jurisdiction

B. BDA: Bi-Direction Amplifier

C. BOM: Bill-of-Material

D. DAS: Distributed Antenna System

E. DASI: Distributed Antenna System Integrator

F. ERCES: Emergency responder communication enhancement system; also referred to as ERCCS: Emergency responder communication coverage system

G. FCC: Federal Communications Commission

H. GROL: General Radio Operator's License

I. NFPA: National Fire Protection Association

J. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.

K. RF: Radio frequency

L. SISO: Single-Input, Single-Output

M. UHF: Ultra high frequency

N. VHF: Very high frequency

1.03 DEFINITIONS

A. BDA: Active RF-emitting device, wired with coaxial cables, for amplification of band-selective or multi-band RF signals via uplink to base station and via downlink from base station to portable two-way radios for enhanced signals and improved coverate; also referred to as analog or digital signal boosters.

B. Fiber DAS Master/Remote: Active RF-emitting device, wired with fiber-optic backbone, for distributing band-selective or multi-band RF signals via uplink to master/remote station and via downlink from master/remote station to portable two-way radio for enhanced signals and improved coverage.

C. ERCES: In-building, two-way communication enhancement system application. Installed to enhance effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within building or structure. System used by firefighters, police, and other emergency services personnel. Also referred to as ERCCS - emergency responder communication coverage system.

D. Public Safety/First Responder: Public safety or first responder agencies charged with responsibilities of responding to emergency situations including, but not limited to, law enforcement departments, fire departments, and emergency medical companies.

E. 47 CFR 90 - Private Land Mobile Radio Services; Current E.

F. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. ICC (IFC) - International Fire Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

L. NFPA 1221 - Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems; 2019, with Amendment (2021).

M. NFPA 1225 - Standard for Emergency Services Communications; 2022.

N. UL 2524 - Emergency Responder Communication Enhancement Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate work with other sections, including fire alarm systems and associated communications cabling. See "Related Requirements" above.

B. Coordinate roof locations for system components and penetrations with Architect.

C. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

D. Retransmission Agreement: Provide prior written approval from FCC license holder(s) of systems being enhanced; meet to review their established criteria for installation prior to beginning work; do not energize system before obtaining written approvals.

E. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

F. Active RF-emitting devices and other active system components require FCC certification prior to installation.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements.

B. Include sufficient information, clearly presented, to determine compliance with specifications and drawings.

C. The following submittals are due as part of the Bid Submittal:

1. Scope of Work
2. Name of company
3. Primary point of contact for this project
4. Relevant Contractor Qualifications
5. References - List of projects and points of contact for past projects of similar size and scope.
6. Personnel Qualifications / Credentials
    a) Manufacturer's qualification statement.
    b) Manufacturer's certification that products meet or exceed specified requirements.
    c) Evidence of installer name and state license number with expiration date.
    d) Submit certificates and/or other documentation as required by the Quality Assurance section of this specification.

D. The following submittals are due as part of the Pre-Construction Submittal:

1. Division of Labor - Identify contractor and sub-contractors that are furnishing, installing, and commisioning/verifying the pathway infrastructure, passive infrastructure, and active infrastructure.
2. Name, Resume, and contact information for the Project Manager
3. Installation Schedule
4. Test Plan
    a) Test equipment to be used
    b) Calibration and test data on the test equipment
    c) After testing is complete, submit RF measurement drawing of each floor of building indicating relative RF field strength for each frequency band required by AHJ.
        1) Drawing clearly indicates areas that have passed or failed based on AHJ required parameters.
5. iBwave Design: Incorporating the results from testing the building/area pre-installation, include iBwave software-simulated radio propagation modeling with heat maps showing predicted signal coverage legels within building.

6. Parts List (Bill-of-Materials): Provide a typed list indicating part name, manufacturer, part number, quantity, description, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).

7. Submit manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:

    a) Cut sheets shall include the following information at a minimum:

        1) Manufacturers name and logo

        2) Size - including physical and loading dimensions

        3) Maximum span length

        4) Weight supported

        5) Type

        6) Fittings to be used

        7) Method of attachment to structure

8. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

9. Shop Drawings:

    a) Submit installation documentation required for plan review and permitting by AHJ and frequency license holder(s), including but not limited to floor plans, showing locations of fire alarm system or other interconnects, enlarged and drawn to identified scale plan view, and riser diagrams.

        1) Riser diagram of Emergency Responder Radio Coverage System (ERRCS) showing proposed and approved cable size and type; coordinated with floor plans and describing circuit class, survivability, and application specific information required by NFPA 72.

        2) Riser diagram of grounding and lightning protection system

        3) Typical wiring diagrams for devices, equipment, interconnects, annunciators, passive components, and active equipment.

        4) Requirements and control unit diagrams for interfacing with other systems.

    b) Scaled layout drawings showing ERRCS components:

        1) Donor and Coverage Antenna locations

        2) Cable routing, with cable type identified

3) Splitters, combiners, and coupler locations

4) Active equipment locations with elevation layout

5) Size/information/locations of all boxes, Pull Boxes, firestopping systems, and access panels.

6) Locations of components, circuits, and raceways; mark components with identifiers used in control unit programming.

7) Elevations of proposed equipment arrangements.

c) Details:

1) Donor Antenna and Coverage Antenna mounting

2) Grounding and Bonding

3) Remote Annunciator: Provide sheet details for exterior and interior views of panel enclosures and clearly show associated wiring information.

d) Calculations

1) RF Link Budget

2) UPS load and runtime

E. The following submittals are due at the Project Completion Submittal, pursuant to the Project Close-Out Instructions in Part 3 of this section:

1. Resubmit approved Pre-Construction Submittals of the following, updated to reflect all changes during construction:

a) Equipment List with length of warranty

b) Cut Sheets

c) Record Drawings

2. Operation & Maintenance Manuals

a) Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

b) Include detailed information on system operation, equipment programming and setup.

c) Include manufacturer's preventative maintenance recommendations.

d) Include contact information for entity responsible for providing contract maintenance and trouble call-back service.

3. Test Reports

a) Installer to submit inspection and test plan prior to closeout demonstration.

b) Acceptance Test - Acceptance and Operational testing shall be in accordance with ICC (IFC) with the following clarifications:

1) The AHJ shall review the as-built drawings and link budget to ensure the physical installation is the same as the as-built drawings during the final system acceptance test.

2) The final system acceptance test shall be witnessed by AHJ or specific designee and shall include a visual inspection of the physical installation of the emergency responder radio system. The AHJ shall conduct an on air test of the subject radio channels in all critical areas and spot tests in non-critical areas. A qualified Engineer or Technician from the designing or installing company shall be present with appropriate test equipment to verify all measurements are in compliance with ICC (IFC) Section 510.

3) As part of the acceptance test, backup batteries and power supplies shall be tested in accordance with Section 510 of the ICC (IFC).

4) Section 510 of the ICC (IFC) - As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to evaluate the system for the entire spectrum range of frequencies used by the AHJ to ensure spurious oscillations are not being generated or received by the building signal booster(s). This test shall be conducted at time of installation and subsequent annual inspections.

F. Maintenance

1. The emergency responder radio system coverage shall be maintained operational at all times in accordance with Section 510 of the ICC (IFC).

2. In the event of a service affecting failure of any portion of the emergency responder radio system, an initial evaluation shall be made by a qualified technician within 24 hours and repairs shall be complete within five working days. Building owner or designee shall notify AHJ forthwith of any service affecting outage.

3. In the event of a non-service affecting failure of any portion of the emergency responder radio system, an initial evaluation shall be completed by a qualified technician on the next business day and repairs shall be complete within 15-business days.

G. Annual Testing and Proof of Compliance

1. Annual testing and proof of compliance shall be in accordance with Section 510 of the ICC (IFC).

H. Warranty Documentation: Submit final executed manufacturer warranties and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 RF PRECONSTRUCTION BUILDING SURVEY FOR ERCES

A. Comply with requirements and standards for initial survey for public safety radio signal strength in accordance with NFPA 1225 (or NFPA 1221) and ICC (IFC).

B. Perform survey after building is substantially completed and prior to start of installation of electrical wiring.

C. Conduct survey using calibrated RF spectrum analyzer, system-compatible radio, or another suitable instrument with traceable NIST certificate of calibration. Analyze RF signal strength of ERCES signal into building and determine if amplification or distribution of signal is required. Determine, measure, calculate and document inbound and outbound signal strengths as required by code.

D. Public safety radio signal level inside Owner's facility determined per code, ordinance, or AHJ requirements.

E. Follow acceptance testing procedure requirements listed in "Field Quality Control" in Part 3.

F. Include report summary and recommendations if ERCES design is required.

1.07 QUALITY ASSURANCE

A. Comply with requirements in accordance with the following:

1. AHJ
2. Frequency license holder(s)
3. Local fire department
4. Applicable local codes
5. ICC (IFC)
6. NFPA 72
7. NFPA 1221
8. NFPA 1225

B. Register installed systems with FCC signal booster registry, regardless of system classification.

C. Obtain permits necessary for installation prior to commencement of work. Include permit costs and inspection fees.

1. Where filings require engineer's signature, submit documents for their review and signature. This responsibility includes furnishing required quantities of floor plans, descriptive notes, and specifications, wiring diagrams, shop drawings and amendment forms.

D. Early completion of ERCES required for Certificate of Occupancy.

1. Complete work results for ERCES at least 15 days before scheduled date of occupancy.

E. Telephone Operator's License: Tests conducted, documented, and signed by person in possession of FCC GROL. Testing personnel have certified and authorized by active RF-emitting equipment manufacturer in requirements for installation and operation of their equipment. Provide personnel qualifications as acceptable to AHJ and frequency license holder(s).

F. RF Preconstruction Building Survey Personnel: Performed by FCC technician holding current GROL license.

G. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1. ERCES design performed by RF system designer.
2. iBwave Level 2 or higher certified personnel.
3. Perform design under direct supervision of professional engineer (PE) or registered communications distribution designer (RCDD) experienced in design of this type of work and licensed in Project Location State.
4. Employing BICSI registered communications distribution designer (RCDD).
5. Designer personnel maintains NICET level II, level III, or Design certified in-building public safety communications (IB-PSC), employed by manufacturer, Contractor, or installer.

H. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience. Certified for compliance with ISO 9001.

I. Software Modifications:

1. Provide use of hardware, software, programming tools, and documentation necessary to modify ERCES software on-site.
2. Modification includes addition, deletion, and changes to system operation and associated labeling.
3. System structure and software without limits on type or extent of software modifications on-site.

4. Modification of software maintains system power without loss of ERCES while modifications are being made.

J. Contractor & Personnel Qualifications

1. Minimum Qualifications of Personnel - The minimum qualifications of the system designer and lead installation personnel shall be in compliance with Section 510 of the ICC (IFC).

a) Responsibility - Design, oversight of installation, and system startup and commissioning.

b) Company Qualifications

1) Minimum of 3 years designing and commissioning Distributed Antenna Systems, with positive references for 2 Projects in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents.

c) Personnel Qualifications

1) Retain on staff an individual with an FCC-issued General Radio Operator's License (GROL).

2) The person(s) conducting testing of the active equipment and signal strength coverage shall be certified to operate the necessary test equipment.

K. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

L. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.08 WARRANTY

A. Active components of the Distributed Antenna System, as well as splitters, couplers, and antennas shall be covered by a 1-year warranty from date of substantial completion, pursuant to Division 1 and General Conditions.

B. Coaxial cable and connectors shall be covered by a 5-year manufacturers warranty from date of substantial completion.

C. The fiber optic cables shall be covered by a minimum of 20+ year Advanced System Warranty from the date of substantial completion.

D. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

E. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Basis of Design: _____

B. Manufacturers: Subject to compliance with requirements, provide products from one of the following, unless specified otherwise.

1. Advanced RF Technologies, Inc. (ADRF)
2. Comba
3. Fiplex Communications
4. Honeywell
5. Notifier
6. SOLiD
7. SureCall
8. TowerIQ
9. Westell
10. _____
11. Substitution: See Section 01 6000 - Product Requirements
    a) Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with necessary modifications to related work, including design fees.
12. Source Limitations: Where possible, furnish system components and accessories produced by one manufacturer and obtained from one supplier.

2.02 SYSTEM DESCRIPTION

A. This is a performance-based turn-key system. Provide new ERCES to provide complete coverage in building for public safety agencies as required by AHJ, consisting of required components (e.g., equipment, conduit, boxes, wiring (including power), connectors, hardware, supports, accessories, software, system programming, and integration) as necessary for complete operating system that provides functional intent indicated. System users receive and transmit radio signals from two-way radios within building.

B. System shall comply with applicable AHJ codes and standards, including but not limited to:

1. ICC (IFC): Section 510, "Emergency Responder Radio Coverage"

2. NFPA 72: Section 24.5, "Two-Way Radio Communications Enhancement Systems"

3. Additionally comply with rules and regulations from local and state governments related to this system.

4. All products included as a part of this system shall be Listed, classified and labeled as suitable for purpose intended.

C. Frequency Range

1. List of Assigned Frequencies:

a) VHF: 136MHz to 174MHz

2. Additional Frequencies: In the event of a revision to frequencies as a result of FCC order or other Authority Having Jurisdiction (AHJ) notification, notify and coordinate with Design Team and Owner to modify or expand the emergency responder radio system coverage at Owner expense. The AHJ may require coverage in the future for FirstNet Broadband Services as NFPA 72, NFPA 1221 and ICC (IFC) Section 510 are amended.

D. System components may include for a complete fully operational system, but are not limited to:

1. Active Components: bi-directional amplifier (BDA), power supplies

2. Passive Components: donor antennas, antenna cabling, coverage antennas, coaxial cable, connectors, splitters, combiners, couplers, equipment racks, enclosures, surge suppressors, filters and grounding/bonding connections.

3. All enclosures shall be painted red with external labeling as required by AHJ.

4. External filters, duplexers, power supplies, or other non-OEM additions or modifications of original equipment are not acceptable, except where technically required and without violating UL 2524 certification. If required, external filters manufactured or certified by ERCES manufacturer are acceptable.

E. Power Sources:

1. System Design Voltage: DC

2. Provide monitoring integrity of power sources in accordance with NFPA 1225 (or NFPA 1221) and ICC (IFC).

3. Provide at least two independent and reliable power supplies in accordance with NFPA 1225 (or NFPA 1221) and ICC (IFC).

4. Primary: Dedicated branch circuits from facility power distribution system in accordance with NFPA 72.

5. Secondary: Storage batteries with capacity to operate system for period specified by NFPA 1225 (or NFPA 1221).

a) External uninterruptible power supplies (UPSs) are not acceptable.

b) Dedicated battery storage capacity:

1) Provide 12 hours of 100 percent system operation capacity.

2) Provide 2 hours and connection to stand-by generator power system that supports 100 percent system operation capacity.

(a) See Section 26 3213.

3) Provide 25 percent additional overall battery capacity correction factor.

F. Wiring and Wiring Methods:

1. General Requirements:

a) Comply with requirements for wiring and wiring methods in accordance with NFPA 70.

b) Conductors and cables installed exposed in spaces used for environmental air (only where specifically permitted): Plenum-rated, listed and labeled as suitable for use in return air plenums.

c) Special Occupancies: Comply with NFPA 70.

d) Comply with NFPA 70 for wire and cable plenum, riser, general-purpose, limited-use, and underground applications.

2. RF Coaxial cable: CMP plenum

3. Singlemode fiber optic cable: LC/APC fiber connectors.

4. Fire-rated cables and cable systems:

a) Provide cable fastening and listing requirements in accordance with NFPA 70.

b) Provide indication of application, use cases, and product make and model for which listing applies.

c) Provide additional classification suffix marking on cable system; observable by AHJ.

d) Emergency Communications Systems: Provide fire-rated protection for control equipment and circuits in accordance with NFPA 72.

e) Unsprinklered building, except high rise, fire-rated cable and associated firestopping of penetrations in accordance with NFPA 72 and NFPA 1225 (or NFPA 1221):

1) Two-hour fire-rated circuit integrity (CI) or fire-resistive cable.

2) Two-hour fire-rated cable system (electrical circuit protective systems).

3) Two-hour fire-rated enclosure or protected area.

4) One-hour fire-rated circuit integrity (CI) or fire-resistive cable.

5) One-hour fire-rated cable system (electrical circuit protective systems).

6) One-hour fire-rated enclosure or protected area.

G. System Monitoring

1. The public safety radio communications enhancement system shall include automatic supervisory and trouble reporting for malfunctions of the signal booster and power supplies that are annunciated by the fire alarm system and UL listed supervising station monitoring company or shall be monitored at a constantly attended location at the building and comply with the following:

a) The integrity of circuit monitoring signal boosters and power supplies shall comply with NFPA 72.

b) System and signal booster supervisory signals shall include the following:

1) Antenna malfunction

2) Signal booster failure

3) Low battery indication when 70% of the 24-hour operation capacity has been depleted

c) Power supply signals shall include the following for each signal booster:

1) Loss of normal power

2) Failure of battery charger

2. ERRS signals on fire alarm annunciator panel shall be labeled "EMERGENCY RESPONDER RADIO SYSTEM." There shall be one green LED signal indicating ERRS in normal mode and one yellow LED indicating system is in trouble.

3. Automatic smoke detection - Smoke detector shall be provided at the location of each ERRS control unit(s), storage battery unit(s) and monitoring panel.

4. Dedicated Panel - A dedicated monitoring panel shall be provided in an area acceptable and approved by the AHJ to annunciate the status of all signal booster locations. In buildings with fire alarm systems, a smoke detector shall be provided above monitoring panel. The monitoring panel

shall provide visual and labeled indication of the following for each signal booster:

a) Normal 120VAC power

b) Signal booster trouble

c) Loss of normal 120VAC power

d) Failure of battery power

e) Low battery capacity

5. In special circumstances where a dedicated panel cannot be installed, a request for modification must be submitted and approved to annunciate on FACP.

H. Coverage / Performance Requirements:

1. Propose and deploy a solution capable of receiving approval of the Authority Having Jurisdiction (AHJ).

2. Upon project completion and testing, the system shall provide coverage for the Public Safety Network frequencies listed above.

3. Network Management:

a) The system shall have a Network Management System (NMS) capable of alarm, monitoring, configuration and control of all Active Components.

b) The system shall be capable of integration with 3rd party SNMP-based NMS products for alarm purposes and provide alarming information to the Fire Alarm System.

4. Coverage:

a) Hardware and cabling installation shall be in accordance with the applicable portions of NFPA 72, ICC (IFC), and NFPA 70.

b) Radio coverage shall be provided throughout the building as a percentage of floor area as follows and shall be tested in accordance with ICC (IFC) with the following additional conditions:

1) Critical Areas - Critical areas such as the emergency or fire command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler valve locations and other areas deemed critical by the AHJ shall be provided with 99% floor area radio coverage.

2) General Building Areas - General building areas shall be provided with 95% floor area radio coverage.

5. Signal strength:

a) Minimum DAQ of 3.0 or better and equivalent signal to interference noise ratio (SINR) applicable to technology for either analog or digital.

b) Downlink: Minimum signal strength of -95dBm throughout coverage area.

c) Uplink: Minimum signal strength of -95dBm received at AHJ radio system or as required by AHJ.

6. Provide FCC certification for active RF-emitting system components prior to installation. Comply with applicable sections of FCC rules, including but not limited to the following:

a) Private land mobile radio services: FCC 47 CFR 90.129.

b) _____

7. Under normal operating condition, maintain antenna isolation between donor antenna and inside antennas, DAS, to 20 dB minimum.

8. Survivability from attach by fire in accordance with NFPA 72, NFPA 1225 (or NFPA 1221), ICC (IFC) or as required by AHJ.

I. Just prior to the end of the 1-year warranty period, return to the project site to:

1. Check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

2. Conduct the yearly testing to check coverage and signal strength requirements per the referenced NFPA 72.

2.03 ACTIVE INFRASTRUCTURE

A. General Requirements:

1. Compliance

a) NFPA 72

b) ICC (IFC)

c) UL 2524

d) NFPA 1221 (or NFPA 1225)

e) NFPA 70

f) NFPA 1

g) CSFM Listing

h) RoHS

i) Buy American Act

2. FCC Certifications

a) 47 CFR 15

b) 47 CFR 90

3. Provide public safety type system with Class A or Class B active RF-emitting devices, as designated by FCC or as required by AHJ.

4. FCC ID must be displayed on product in accordance with FCC.

5. Capable of field configuration via programmable software for frequency channels with adjustable bandwidths as specified by AHJ.

6. Active RF-emitting devices support Class A or Class B operation.

   a) Class A: Provide channel selective type with 75kHz, 62.5kHz, 50kHz, 37.5kHz, 25kHz, and 12.5kHz channel bandwidth options.

   b) Class B: Provide wide-band filters of greater than 75kHz to full-band.

7. Include oscillation suppression circuitry to protect public safety radio system in case of system malfunction or other causes. Circuitry allows for real-time automated oscillation correction and immediate detection capable of generating oscillation alarm, combined with programmable limited operation or auto-shutdown if performance migration fails.

8. Include uplink noise suppression function to eliminate uplink noise while in standby (e.g., no radio transmission from within building). Systems that produce measurable level of uplink noise while in standby are not acceptable.

9. Include uplink and downlink squelch, per channel, per timeslot.

10. Provide redundant fiber ports where applicable.

11. Provide rack-mounted fiber DAS master unit.

12. Fiber DAS digital signal: up to 40km or 18dBo maximum loss on singlemode fiber (SFP).

13. Rated minimum of 85dB plus/minus 2.0dB and gain adjustable by minimum of 28dB range.

14. Maximum propagation delay range: designer determined, adjustable and with filter delay options for compliance with system requirements or per AHJ.

15. Maximum noise: 9dB; throughout its published operable uplink gain range.

16. Include built-in automatic supervision of system malfunctions, including battery systems where applicable.

17. Non-OEM equipment add-ons and modifications are not acceptable.

18. Enclosure: NEMA 250 Type 4

B. Bi-Directional Amplifier (BDA)

1. Frequency Range: See System Description above.
2. Output Power: Size per RF link budget
3. Signal Booster Enclosure: Red, NEMA-4 (UL 508A)
4. Impedance: 50 Ohm
5. RF Connectors: N-Female

C. UPS - Uninterruptible Power Supplies

1. All active equipment serving this system shall be connected to a UPS, and emergency/stand-by generator power if available.
2. Performance Description:
   a) If normal/primary power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.
   b) When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
   c) The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
      1) Inverter is switched to battery source.
      2) Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
      3) Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
      4) THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
   d) Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection
   e) Controls - shall include the following:
      1) Inverter on/off
      2) UPS start
      3) Battery test
      4) Alarm silence/reset

5) Output voltage adjustment

f) Monitoring

1) Alarm indications shall include the following:

(a) Trouble alarm

(b) Battery system alarm

2) Alarms shall notify Owner via integration with Fire Alarm monitoring.

3. Design Requirements:

a) Minimum Duration of Supply:

1) If battery is sole energy source, supply rated full UPS load current at 80% power factor, duration of supply shall last a minimum of 24 hours.

2) Where equipment is connected to an automatic-starting, engine-driven generator serving the system's dedicated branch circuit with at least 12 hours of 100% system operation capacity, duration of battery shall last a minimum of 2 hours at full UPS load current at 80% power factor.

b) Include load and UPS-sizing calculations in pre-construction submittals.

2.04 PASSIVE INFRASTRUCTURE

A. General

1. Provide passive components required in RF system design as required for complete system, included but not limited to passive RF-emitters, design frequency range, gain values, radiation patterns or heatmaps, voltage standing wave ratio, polarization, power handling, impedance, connector types, environmental ratings, device losses, isolation characteristics, signal rejection, component size, form factor, attenuation values, output accuracy, and thermal stability.

2. Submit equipment listings, manufacturer requirements, and quantities on products not limited to the following items if utilized in the system design.

B. Antennas

1. Donor Antennas

2. Coverage Antennas

3. Antenna Support Infrastructure

a) Comply with TIA-5053-A

C. Coaxial Infrastructure

1. Splitters
2. Duplexers-notch filters
3. Tappers
4. Passive Combiners
5. RF Cables (including but not limited to fiber, coaxial, hardline)
6. Antenna discharge units
7. Enclosures: NEMA 250 Type 4
8. Connectors and jumpers
9. Coaxial Surge Protectors -To be utilized for cables connected to an antenna/device subject to potential lightning strikes.

D. Pathway Survivability

1. All system riser cables shall be in conduits and shall consist of one or more of the following:

a) Buildings where interior exit stairway and ramp enclosure are required to have fire-resistance rating of no less than two hours:

1) 2-hour fire-rated circuit integrity (CI) cable
2) 2-hour fire-rated cable system
3) 2-hour fire-rated enclosure or protected area
4) 2-hour performance alternative approved by the AHJ

b) Buildings where interior exit stairway and ramp enclosure are required to have fire- resistance rating of no less than one hour.

1) 1-hour fire-rated Cl cable
2) 1-hour fire-rated cable system
3) 1.-hour fire-rated enclosure or protected area
4) 1-hour performance alternative approved by the AHJ

2.05 REMOTE ANNUNCIATOR

A. Provide dedicated supervisory monitoring panel within fire command center next to FACU, fire alarm system annunciator, or other location as designated by AHJ to annunciate status of active RF-emitter device locations. Include visual and labeled monitoring panel indication for the following and for each active RF-emitter:

1. Normal AC power
2. Signal booster trouble
3. Antenna failure

4. Loss of normal AC power
5. Failure of battery charger
6. Low battery c
7. Active system component failure

2.06 ACCESSORIES

A. Cables for network connections:
   1. Comply with manufacturer's requirements.
   2. See Section 27 1000.

B. As-Built document cabinets:
   1. Provide as-built document cabinet with size as indicated or as required.
   2. Cabinet: Steel with red finish; permanently identified with text "AS-BUILT DRAWINGS"; keyed to match ERCES equipment.
   3. Basis of Design: _____

C. Antenna discharge unit.

D. Surge Protection:
   1. Line voltage surge protection: Listed; provide for each line voltage circuit that supplies operating power for ERCES equipment.
   2. Low voltage surge protection: Listed; voltage/current ratings suitable for circuit to be protected; provide for each power limited low voltage circuit that exits protected premises.
   3. Basis of Design: _____

PART 3 - EXECUTION

3.01 EXAMINATION

A. If the installed infrastructure is insufficient for the proposed system, notify the Architect and Design Consultant immediately. Review drawings and/or building to ensure the following:
   1. Examine for adequate space for all equipment, antennas, cabling, etc.
   2. Examine for adequate available power for all active equipment.
   3. Examine for adequate available grounding and bonding system.
   4. Examine pathway elements intended for cable installation. Check raceways, cables and other elements for compliance with accessibility for installation and maintenance, and other conditions affecting installation.

5. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where equipment is to be installed.

B. Verify that field measurements are as indicated.

C. Verify that characteristics of system components are consistent with the indicated requirements.

D. Verify that circuit wiring installation is completed, tested, and ready for connection to system where applicable in accordance with NFPA 70.

E. Verify that mounting surfaces are ready to receive system components.

1. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not begin installation until unacceptable conditions are corrected.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General

1. Install in accordance with NFPA 1221 (or NFPA 1225), NFPA 72, NFPA 70, state and local codes, manufacturer's instructions, and as indicated on drawings.
2. Install products in accordance with applicable requirements of NECA 1 (general workmanship).
3. When cable penetrates fire-rated barrier, installation shall meet Section 07 8400 - Firestopping.
4. Per NFPA 72, provide monitoring and alarm capabilities to the fire alarm system in Section 28 3111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM.
5. All permitting and licensing fees for this system shall be paid by the Contractor.
6. Wiring Method: Install cables concealed in accessible ceilings, walls, and floors where possible. Install cables in raceways as indicated. Conceal raceways and wiring except in unfinished spaces. See Section 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS for more information.
7. Identification shall meet Section 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS
8. Provide dedicated 20 amp branch circuit for battery system.

9. Wiring in Telecommunication Rooms: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

10. Conceal conduit, junction boxes, conduit supports, and hangers in finished areas. Conceal conduit, junction boxes, conduit supports, and hangers in unfinished areas; maintain code required access and clearances.

11. UL 2524 Listed Equipment: Do not drill holes or field fabricate openings in UL 2524 listed equipment; this voids warranty, listing, and enclosure rating.

    a) Mark equipment front with identifier "DO NOT DRILL INTO THIS CABINET" label.

    b) See Section 26 0553.

12. Donor antenna mounting:

    a) Fixed permanently on building where approved by AHJ.

    b) Moveable: Mount identification in accordance with ICC (IFC) and ICC (IBC).

13. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for the purpose. Provide ac-powered equipment with integral surge suppressors, complying with UL 1449.

14. Enclosure installation

    a) Wall panels/enclosures shall be installed on a plywood backboard or attached to a masonry wall. They should not be attached to sheet rock (gypsum wall board).

B. Grounding and Bonding

1. See Section 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS for more information.

2. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)

3. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.

4. Install grounding and bonding per manufacturer's installation instructions and in compliance with TIA-607, IEEE 142, IEEE 1100, NFPA 70 and NECA/BICSI 607.

5. Required Bonding Connections:

a) Provide one individual bonding conductor from each enclosure to the SBB in the room. Each conductor is to be “home run”; do not “daisy chain” the connections.

b) Provide and install one individual bonding conductor to the SBB from the entrance protector for any coaxial cable connected to a roof-mounted donor antenna.

c) Provide and install one individual bonding conductor to the SBB from any continuous conduit installed for systems that extends into the equipment room.

d) Where structural steel is available, is continuous, and properly bonded to the electrical grounding system, provide one individual bonding conductor from the SBB and connect to the nearest structural steel member. Indicate this location on the Record Drawings as well as the conductor size, length, and routing.

e) Where structural steel is not available, provide one individual bonding conductor from the SBB and connect to ground bus of the serving electrical panel (that the Active Equipment is connected to). Indicate this location on the Record Drawings as well as the conductor size, length, and routing. This conductor shall be routed in conduit and insulated.

f) Size all bonding conductors per the Table in Section 2 of this specification.

g) Provide and install all grounding connections per the referenced codes, standards, and guidelines, and per manufacturers’ instructions.

6. Cable Identification:

a) Label both ends of each bonding conductor within 6 inches of a connector terminal or splice. All labels shall include the following in addition to specific labeling requirements for each conductor. IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.

7. Testing

a) As a minimum test, as described below, all metallic wires and cables installed under these Specifications.

b) Test the bonding conductors and the terminal connectors for total resistance between the equipment item being bonding and the main telecommunications bonding point in the room (SBB). This resistance shall be less than 0.10 Ohm.

c) Recommended test equipment:

1) An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

8. Shop Drawings & Record Drawings

a) The Shop Drawings and Project Record Drawings shall show the types and locations of installed bonding conductors.

3.03 COAXIAL INFASTRUCTURE INSTALLATION

A. Cable products shall be sweep tested at the factory before shipping at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

B. Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths.

C. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.

D. Cable shall not be installed in same raceway with power cable.

E. Do not use cable pulling lubricants, without written approval from the Design Consultant and cable manufacturer.

F. Do not exceed manufacturer's recommended minimum bending radii.

G. Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

H. Signal Equalization: Where system performance may be degraded in certain operating modes, revise component connections and install distribution amplifiers and attenuators as required, providing a balanced signal across the system.

I. Label both ends of coax cable. Refer to “Identification/Labeling” part of this specification section.

J. Install coaxial cables in continuous lengths except for terminations; no splices are permitted. Avoid sharp bends or other physical distortions in the installation of cable. Cable terminations shall be properly installed with no visible sign of cable braid between cable end and the connector.

K. Maintain signal integrity. During installation, correct open grounds, broken shields, and other possible causes of poor RF signal quality.

L. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

M. Labeling

1. Provide sign on all doors providing access to ERRCS stating: “EMERGENCY RESPONDER RADIO COVERAGE SYSTEM EQUIPMENT INSIDE.”

2. Provide sign on donor antennas stating: “EMERGENCY RESPONDER RADIO COVERAGE SYSTEM."

3. Label cabling per TIA-606.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Manufacturer's Field Services: Provide service of factory-trained technician authorized by manufacturer to technically supervise and participate during pretesting and acceptance testing of system. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Perform initial inspection and testing in accordance with NFPA 1221 (or NFPA 1225) and requirements of AHJ for ERCES; document each inspection and test.

1. Consult manufacturer's manual to determine proper testing and acceptance procedures when system is equipped with optional features.

2. Acceptance testing for ERCES is required upon completion of installation.

3. System gain requires setting and documented at time of final system test.

4. Provide coverage testing in accordance with NFPA 1221 (or NFPA 1225) and ICC (IFC) and as required by AHJ.

a) Testing Procedures:

1) Test building coverage for emergency communication systems, inside and outside, to and from the building, for the following minimums indicated in Part 2 under 'Radio Coverage' paragraph.

2) Capable of being tested throughout coverage area for both uplink and downlink by local fire department; received signal strength indicator (RSSI) measurement only.

3) Perform tests for cable insulation resistance and acceptance testing procedures in accordance with ICC (IFC) and NFPA 1225 (or NFPA 1221).

4) Utilize calibrated portable radios of same make and latest model used by AHJ.

5) Utilize spectrum analyzer or similar for monitoring oscillations from RF-emitting or other system active equipment.

6) Measure gain values of every ERCES amplifier and review test result against baseline data kept on file for annual testing.

7) Divide coverage for testing, options:

(a) Maximum 20 equal areas, per building floor. From center of area, use two-way communications to and from outside of building for interfacing with AHJ's public system.

(1) Comply with NFPA 1225 (or NFPA 1221) and ICC (IFC) maximum square footage per area.

(2) Failing to communicate in more than one test area is failed acceptance test.

(3) Failing to communicate in two adjacent areas is failed acceptance test.

(b) Utilize radios for simultaneous voice quality checks; subjective by testing personnel. Position one radio within 10 feet to indoor antenna and second radio distance furthest away from indoor antenna. Both radios select different frequencies within same band for testing.

(1) Signal strength less than DAQ 3.0 is failed acceptance test.

8) Nonconforming work:

(a) Repositioning test location for better results is not allowed.

(b) Alter system to meet coverage requirements and retest for acceptance for compliance.

5. Record rated dB and gain adjustments and documented at time of final system test.

6. Provide documentation in submittals for "initial acceptance testing requirements" in accordance with NFPA 1225 (or NFPA 1221) Chapter 20, Testing.

D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

E. When testing and acceptance has been completed to satisfaction of both Contractor's job foreman and representatives of manufacturer and Owner, forward notarized letter cosigned by each attesting to satisfactory completion of said testing to Owner and fire department. Installer to submit results indicating inspection and testing results, and corrective actions taken.

F. Leave system in working order, and without additional expense to Owner, replace defective materials and equipment provided.

3.05 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform systems startup.

B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

C. Adjust for proper operation within manufacturer's published tolerances.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Provide instruction as required for interfacing with system and making benefit of ERCES to achieve NFPA 1225 (or NFPA 1221) requirements.

2. Provide hands-on demonstrations of operation system components and functions; have drawings and operator instructions available during demonstration.

B. Training - Owner Personnel Instruction:

1. Provide the following instruction to designated Owner personnel:

a) Hands-on instruction: On-site, using operational system.

b) Classroom instruction: Owner furnished classroom, on-site or at other local facility.

c) Factory-certified instruction: ERCES manufacturer's authorized training facility.

2. Basic operation: One 1-hour session pre-closeout for attendant personnel, security officers, and engineering/facilities staff; combination of classroom and hands-on.

3. Detailed operation: One 2-hour session post-occupancy for engineering staff holding appropriate State license to operate, service, or maintain ERCES; combination of classroom and hands-on.

4. Furnish services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

5. Provide means of evaluation of trainees suitable to type of training given and report results to Owner.

3.08 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.09 MAINTENANCE

A. Provide to Owner as alternate to base bid, separate maintenance contract for service and maintenance of system for entire manufacturer's warranty period to include work described below; include complete description of preventative maintenance, systematic examination, adjustment, inspection, and testing, with detailed schedule.

B. Perform routine inspection, testing, and preventative maintenance as required by NFPA 1225 (or NFPA 1221) including the following:

1. Maintenance of devices connected to system.

2. Repairs required outside of warranty as approved by Owner.

3. Record keeping required by NFPA 1225 (or NFPA 1221), frequency license holders, and AHJ.

C. Annual Maintenance and Proof of Compliance:

1. ERCES must remain in operation in accordance with ICC (IFC).

2. System tested annually as part of routine maintenance or when structural changes, additions, or space layout configurations can affect initial coverage areas.

3. As part of annual testing, verify active RF-emitting devices for loss of gain compared to when system was originally commissioned.

4. Test power supplies and batteries for loss of power and communication failure.

5. Upon completion of annual test provide report to Owner and AHJ.

D. Provide trouble call-back service upon notification by Owner.

1. Provide on-site response within four hours of notifi

2. Include fee schedule for call-back service during and outside normal working hours; include definition of normal working hours.

E. Maintain on-site log listing date and time of each inspection and call-back visit, condition of system, nature of trouble, correction performed, and parts replaced.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and to all following Sections within Division 28.

1.02 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation, and utilities.

B. Division 28 of these Specifications, and Drawings numbered with prefixes TY, generally describe these systems, but the scope of the Electronic Safety & Security Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications, along with the device schedules located on drawing legend sheets, define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.03 ABBREVIATIONS AND ACRONYMS

ADA	Americans with Disabilities Act
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ETL	Electrical Testing Laboratories, Inc.
FCC	Federal Communications Commission
FM	Factory Mutual
IEEE	Institute of Electrical and Electronic Engineers
LED	Light Emitting Diode
NEC	National Electric Code
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NRTL	Nationally Recognized Testing Laboratory
OEM	Original Equipment Manufacturer
OFCI	Owner Furnished Contractor Installed
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories
UON	Unless Otherwise Noted

1.04 DEFINITIONS:

A. Whenever used in specifications or drawings, the following terms shall have the indicated meanings:

1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

2. Approved - Labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

3. Approved Equivalents - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the Contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant’s acceptance or rejection is final.

4. As Directed - As directed by the Contract Administrator, or their representative.

5. Concealed - Embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.

6. Conditionally Approved – The manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification

requirements. Contractor shall adhere to submittal review process for final approval on products.

7. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is "the Architect".

8. Design Consultant - Where referenced in this Division, “Design Consultant” is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions.

9. Furnish - “To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations.” When ‘furnish’, ‘install’, ‘perform’, or ’provide’ is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor “provide” is implied.

10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.”

11. Install - “To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use.”

12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. NRTL certification/mark and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL’s that are acceptable to the AHJ, and standards that meet the specified criteria.

13. Provide - “To furnish and install complete, and ready for the intended use.”

14. Prime Contractor – a project’s overall Contractor responsible for all Divisions of Work, usually identified as a General Contractor or Construction Manager At Risk.

15. Submit - Submit to Contract Administrator for review.

16. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

a) Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

b) Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

17. Value Engineering (VE): A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

18. Wet Location - A location subject to saturation with water or other liquids. Pathways installed in wet locations do not protect cables from moisture such that cables installed in pathways within wet locations must be identified by their manufacturer for use in wet locations.

a) For example: Slab-on-grade construction where pathways are installed underground or in or under concrete slabs that are in direct or indirect contact with soil (e.g., sand and gravel with or without a moisture barrier) is considered a "wet location."

19. (*) Asterisk – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the Contractor to meet required specifications.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by, or acceptable to, the Design Consultant as equivalent to the item or manufacturer specified".

1. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.

2. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

3. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.05 REFERENCE STANDARDS

A. Execute Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected

by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting Work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If a conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Design Consultant, without additional compensation. Contractor shall be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes. Refer to individual Sections for exact codes, references, and standards.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other Divisions for Electronic Safety and Security Work to be included but not listed in Division 28 or indicated on the Security or Fire Alarm Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing Work, and make do provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.

C. Refer to Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the Work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.

D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.

E. Maintain a project manager on the jobsite always to coordinate this Work with other trades so that various components of the Division 28 systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

G. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 1 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule to ensure successful achievement of schedule dates.

I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the Work. Install and coordinate the Work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.

J. Wherever the Work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the Work with the Work of other trades. Detailed Work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.

K. Before commencing Work, examine adjoining Work on which this Work is in any way affected and report conditions, which prevent performance of the Work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.

L. In cases of doubt as to the Work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.

M. Measurements and Layouts: The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.

2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.

3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.

4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.

6. Indicate required installation sequence to minimize conflicts between entities.

7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include Work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

D. Refer to Coordination requirements in specific Sections for additional information.

1.08 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Design Consultant that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Design Consultant's designated representatives. Contractor shall allow for the Design Consultant Review Time as specified.

Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Design Consultant Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Design Consultant review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Design Professional. They shall not be copies of the work product of the Design Professional. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification Sections. Only resubmit those Sections requested for resubmittal.

H. Unless noted otherwise within each individual Section, submittals shall be provided for approval in four distinct submittal stages:

1. Pre-bid

    a) Generally, means submittals required no less than two weeks prior to the due date for the submission of bids, such as:

        1) Product substitutions, approved alternate, or equivalent requests to be reviewed for approval (Prior to Bid). Coordinate with Division 1.

        2) Alternate personnel credentials to be reviewed for approval.

2. Bid

    a) Generally means submittals required at the time of the submission of bids, such as:

        1) Unit Pricing (if required by Sections in this Division)

        2) Personnel Qualifications

        3) Contractor Qualifications

        4) Voluntary Bid Alternates

3. Pre-Construction Submittal

a) Generally, means submittals required after the award of the project to the winning bidder and prior to starting construction. At a minimum, Pre-construction submittal shall include:

1) The project name.

2) The submitted contractor's company name, the individual's name responsible for the submittal, and contact information for that individual.

3) The Prime Contractor's stamp, which shall certify that the stamped submittals have been check by the Prime Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

b) Submittals for this division shall be divided and titled in the following manner:

1) Division 28 Electronic Security Systems

2) Division 28 Fire Alarm Systems

3) Division 28 Mass Notification System

4) Division 28 Distributed Antenna System for Public Safety Radio Coverage

c) Submit the following items within 4 weeks after the notice to proceed:

1) Division of Labor amongst sub-contractors. Include:

(a) Information on each sub-contractor:

(1) Company Name

(2) Address

(3) Name of project manager for this project, including:

(4) E-mail

(5) Telephone number

(b) A detailed description or matrix identifying who is responsible for furnishing, installing, and verifying the following system components:

(1) General requirements:

(2) Various system power, backup power, and grounding/bonding items.

(3) Various conduit and other common Work items.

(4) Various low-voltage wires/cabling and terminations.

(5) Various structural and seismic items (including design)

(c) Individual Division 28 Sections

2) Updated Personnel and Contractor Qualifications (resubmit if there are no changes)

3) Schedule - A Gantt chart or Milestone list that includes the following timetables:

(a) Pre-Construction Submittals

(1) Include time for resubmittals.

(2) Unless otherwise stated elsewhere within these specifications, assume [1] week review time for the Prime Contractor and 2 weeks for the Architect/Division 28 Design Consultant for each submittal.

(b) Material purchase/shipping schedules (to identify any long lead times for critical components)

(c) Conduit Installation

(d) Cabling Installation

(e) Cabling termination and testing

(f) Power and backup power availability

(g) Equipment installation and testing

(h) System startup and configuration

(i) As-built drawings

(j) Operation and Maintenance Manual submission, resubmission, and approval

(k) Final Site Observation for Substantial Completion approval [to be at least [2] weeks prior to overall project Substantial Completion date]

(l) Owner Training sessions

(m) Other items as required by individual Sections in this Division.

4) Equipment List - A typed list, indexed by Specification Section, of products specifically identified by part number (no wild card characters) within each specification Section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.

5) Manufacturers' datasheets:

(a) At a minimum all product datasheets shall contain the following:

(1) The manufacturers' name and logo somewhere on the page

(2) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.

(3) For datasheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.

(4) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

(b) Datasheets are to be in the same sequential order as is presented within the specifications.

6) Warranty Information – For warranties required by this specification and other Related Sections, submit warranty terms and conditions for each system or product. These shall contain the following:

(a) Length of warranty period

(b) What is covered?

(c) All disclaimers, limitations, etc.

(d) What, if anything, is not covered

7) Samples – refer to individual Sections for exact sample requirements.

(a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the Work will be judged. Contractor or Manufacturer is to cover return shipping if sample is to be returned.

8) Shop Drawings – Refer to individual Sections for exact Shop Drawing requirements.

d) And as required by individual Sections in this Division

4. Project Completion

a) Generally means, unless otherwise noted, submittals required to be submitted [4] weeks prior to Substantial Completion, for the Design Consultant to reference during the "Final Punch" Site Observation. Project Completion, aka "Close-out Documents" include the following:

1) Record Drawings

2) Operation and Maintenance Manuals

3) Owner training syllabus

4) Recorded Owner Training

5) Project test reports

6) Cable Databases (as applicable)

7) Warranty Certificate(s)

8) And as required by individual Sections within this Division

I. Provide submittals in sufficient detail to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

J. Refer to individual Sections for additional submittal requirements.

K. No part of the Work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the Work have been submitted and accepted.

L. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

M. Submittals shall contain the following information:

1. The project name.

2. The applicable specification Section and paragraph.

3. Equipment identification acronym as used on the drawings.

4. The submittal dates.

5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

6. Submittals not so identified will be returned to the Contractor without action.

N. The checking and subsequent acceptance by the Design Consultant and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent Work. Contractor shall request and secure written acceptance from the Design Consultant and Contract Administrator prior to implementing any deviation.

O. Video Recordings: Record training and demonstrations in .AVI format, unless noted otherwise in Division 01 specifications or were approved by the Owner.

1.09 SUBSTITUTIONS

A. Refer to Bid documents, General and Supplementary Conditions and Division 01 Specification Sections for limitations and restrictions on substitutions in addition to requirements specified in this Section.

B. For products, materials, equipment, or systems for which this Division specifically identifies, the Contractor shall use it as the basis for their bid. However, if the Contractor feels a substitute is appropriate for consideration they may submit, as required in these documents prior to bid, for approval by the Design Consultant.

C. Materials, products, and equipment described in the Bidding Documents establish a standard of required function, performance, dimension, appearance and quality to be met by the proposed substitution.

D. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications, UON.

E. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this Section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Design Consultant by the Contractor, Contractor warrants to the Design Consultant, Contract Administrator, and Owner the following:

a) Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

b) Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

c) Proposed substitution has received necessary approvals of authorities having jurisdiction.

d) Same warranty will be furnished for proposed substitution as for specified Work.

e) If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f) Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

F. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.

3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. The following must be received before electronic drawing files will be sent:

1. Engineer’s release agreement form

2. Payment

1.11 QUALITY ASSURANCE

A. Execute all Work under this Division in a thorough and professional manner by competent and experienced work persons duly trained to perform the Work specified.

B. Install Work in strict conformance with all manufacturers' requirements and recommendations unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE DATA

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer’s review, and for the Owner’s use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers, and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Design Consultant that the manuals have been posted.

If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Design Consultant's designated representatives.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories (UL LLC) certification labels/marks, and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and always, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material, and equipment.

1.15 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are required to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

E. Perform the remedial Work within 48 hours, upon notice from the Contract Administrator or Owner.

F. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one-year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 FIELD CONDITIONS

A. Conditions Affecting Excavations: The following project conditions apply:

1. Locate, maintain, and protect existing building services that transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

B. Use of explosives is not permitted.

C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 FEES AND PERMITS

A. Secure and Pay all required fees and obtain all required permits related to the Electronic Safety and Security Systems' installation.

B. Pay royalties or fees in connection with the use of patented devices and systems.

3.03 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY.

B. Maintain all code required clearances and clearances required by manufacturers.

3.04 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions, and ceilings for all electrical Work that passes through construction. Refer to 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY.

B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass-through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

D. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

E. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the Work under this division. Excavation shall be in conformance with applicable Divisions and Sections of the Specifications.

F. Restore roads, alleys, streets, and sidewalks damaged during this Work to the satisfaction of Authorities Having Jurisdiction.

G. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.

H. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the Work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the Work.

I. Slope sides of excavations to comply with local, state, and federal codes and ordinances. Shore and brace as required for stability of excavation.

J. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state, and federal codes and authorities. Maintain shoring and bracing in excavations regardless of period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inch below finished grade elevation.

K. Install sediment and erosion control measures in accordance with local codes and ordinances.

L. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

M. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within dripline of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

N. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 ft; plus, a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within dripline of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

O. Trenching: Excavate trenches for communications installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceway and cables.

2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.

5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

P. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

Q. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For raceway and cables less than 30 inch below surface of roadways, provide 4 inch thick concrete base slab support. After installation and testing of raceway and cables, provide a 4 inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas use excavated or borrowed materials.

R. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

S. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inch in loose depth for material compacted by heavy equipment, and not more than 4 inch in loose depth for material compacted by hand-operated tampers.

1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10 ft intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.

T. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

U. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

V. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D1557 and not less than the following percentages of relative density, determined in accordance with ASTM D4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inch of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

b) Areas Under Walkways: Compact top 6 inch of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

c) Other Areas: Compact top 6 inch of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content

and to prevent water appearing on surface during, or after, compaction operations.

W. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.05 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install Work under this Division.

B. Obtain permission from the Contract Administrator prior to cutting. Do not cut or disturb structural members without prior approval from the Contract Administrator and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Contract Administrator and Structural Engineer prior to performing any Work. Obtain approval from Contract Administrator and Structural Engineer for all core drills and penetrations at least four days prior to performing Work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by Work to the condition of adjoining surfaces in a manner satisfactory to the Contract Administrator.

3.06 PAINTING

A. Refer to Division 09 Section “Painting” for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual Sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer’s instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming, and special finishes are specified in the individual equipment Specification Sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.07 CLEANING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in always maintaining reasonably clean premises.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.

C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

D. Touch up and restore damaged finishes to their original condition.

E. All Electronic Safety and Security infrastructure and equipment shall be thoroughly vacuumed and wiped clean, in accordance with the manufacturers' instructions, prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

3.08 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all Electronic Safety and Security infrastructure and equipment furnished and/or installed under this Division.

B. Check and test protective devices for specified and required application and adjust as required.

C. Verify that completed wiring system is free from short circuits, open circuits, unintentional grounds, and low insulation impedances.

D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

E. Refer to individual Sections for additional and specific requirements.

3.09 START-UP OF SYSTEMS

A. Prior to start-up of Electronic Safety and Security systems, check all components and devices, to confirm compliance with manufacturers’ recommended installation procedures.

B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

C. Refer to individual Sections for additional and specific requirements.

3.10 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit results of systems tests and adjustments per each individual Section.
2. Submit complete Operation and Maintenance Data.
3. Submit complete Record Drawings.
4. Perform all required training of Owner’s personnel.
5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
6. Perform start-up tests of all systems.
7. Remove all temporary facilities from the site.
8. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.

B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of 5 business days' notice prior to the review for project sites.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a “final list” of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.11 CONNECTED PRODUCTS CYBERSECURITY

A. Software Requirements

1. All software and firmware in products furnished or provided by the Contractor shall be the latest and most up to date version(s) provided by the manufacturer.

2. All equipment requiring users to log on using a password shall be configured with user/site-specific passwords). No system/product default passwords shall be allowed. Coordinate user logins and passwords with Owner prior to system setup.

   a) Passwords shall always be guarded and protected, including during construction phase of the project. Passwords shall not be written on or in any device, enclosure, or room where access could be obtained by others.

   b) Passwords shall be transmitted to Owner, and Design Consultants via secure methods, obscuring or encrypting the document to be transmitted. This document shall be secured while stored for submission with the project(s) other submittals, including Shop Drawings and As-Built documentation.

3. Refer to individual Sections for additional software requirements.

B. Edge Device Requirements

1. All edge-connected devices included but not limited to security cameras, readers, intercom stations, controllers, furnished or provided by the Contractor shall support and utilize X.509v3 certificate-based authentication.

   a) Certificates shall be issued by a trusted PKI (Public Key Infrastructure) defined by the Owner or an approved Certificate Authority (CA).

   b) Self-signed certificates are not acceptable unless approved by Owner.

2. All edge-connected devices shall support and utilize Transport Layer Security (TLS)1.3 encrypted communication to the host server.

3. All edge-connected devices shall support and utilize Secure Boot funtionality to ensure only authorized firmware is installed on the device by verifying the digital signature of each firmware component during startup.

4. Refer to individual Sections for additional edge device requirements.

C. Network and Cybersecurity Requirements

1. For all Electronic Safety and Security Systems that have Contractor-provided equipment with an Ethernet/LAN port, Contractor shall coordinate with Owner's IT staff regarding Owner's network and cybersecurity requirements.

2. The Contractor shall take positive measures to prevent the introduction of cybersecurity threats to the Owner's technology infrastructure and network. These measures shall include but are not limited to:

a) Coordinate with the manufacturer to ensure newly procured equipment does not have any cybersecurity notices, bulletins, or alerts. Provide a letter to the Design Consultant with the submittal documents for that Specification Section confirming there are no active or known cyber threats.

b) Ensure all installers/technicians installing or configuring equipment are trained on the prevention of introduction of cyber threats to electronics.

c) The Contractor shall assess any cyber threats / vulnerabilities associated with the specified equipment, prior to procurement/installation. If cyberthreats are discovered, notify the Design Consultant immediately; but not greater than one day. Provide the make and model of the associated equipment and the vulnerability.

d) Follow additional cybersecurity requirements and procedures as directed by the Owner's IT staff.

D. Refer to individual Sections for additional Networking and Cybersecurity Requirements.

3.12 EARLY OCCUPANCY

A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.

1. Refer to individual Sections for additional requirements.

B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Grounding and Bonding

B. Pathways for Electronic Security

1. Hangers and Supports
    a) Cable hook supports (J-hooks)
    b) Cable supports (saddle or loop)
2. Conduits and backboxes
    a) Conduits
    b) Outlet Boxes
    c) Junction Boxes
    d) Pull Boxes

C. Surface Raceways

D. Underground Ducts and Raceways

E. Sleeves and Sleeve Seals

F. Access Panels

G. Fire Stop Systems

H. Security Fastenings

I. Identification Common Work for Electronic Security

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 07 THERMAL AND MOISTURE PROTECTION

C. Division 26 ELECTRICAL

D. Division 27 COMMUNICATIONS

E. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

F. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

G. Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

1.03 ACRONYMS AND DEFINITIONS

A. Common Work: Work specified in this section.

B. Conduit Body: A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.

C. Conveniently Accessible: Capable of being reached from the floor or via the use of an 8 ft step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.

D. Firestop System Assembly: Firestopping products tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.

E. Ground or Grounding: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

F. Plenum: A compartment or chamber to which one or more air ducts are connected and forms part of the air distribution system.

G. Plenum-rated: A product listed by a NRTL as being suitable for installation into a plenum space.

H. Surface Metal Raceway: A metallic raceway intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

I. Surface Nonmetallic Raceway: A nonmetallic raceway intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

J. UL: Underwriters Laboratory

1.04 REFERENCES

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ASHRAE Handbook - ASHRAE Handbook Online; Online Edition.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.

D. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

E. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

F. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

H. FM 4991 - Approval Standard of Firestop Contractors; 2013.

I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

J. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

K. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

L. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.

M. UL (DIR) - Online Certifications Directory; Current Edition.

N. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

O. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

P. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Adjust location of pathways for communications systems to accommodate the work to prevent interferences, both anticipated and encountered. Determine the route and location of each conduit prior to fabrication:

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.

2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for Division 28 equipment that are behind finished surfaces or otherwise concealed.

1.06 SUBMITTALS

A. Follow the requirements for submittals in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS.

B. Pre-bid submittal:

1. For products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information. Be prepared to submit a sample should the Design Consultant request an evaluation.

C. Pre-construction submittal

1. Product Data

a) Manufacturers name and logo

b) Size – including physical and loading dimensions

c) Maximum span length

d) Weight supported

e) Type

f) Fittings to be used

g) Method of attachment to structure

h) Firestop system assembly information for each system to be installed:

1) Documentation from UL catalog for each system proposed. This documentation shall include the following information:

(a) Firestop manufacturer

(b) UL system number

(c) F, T, and L Ratings

(d) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

2. Shop Drawings:

a) Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pull boxes, firestopping systems, and access panels.

1) Each pathway shall be identified by type and size on the drawings.

(a) Example #1: 4” EMT

(b) Example #2: 2” IMC

2) Each grounding conductor shall be identified by size (and insulation):

(a) Example: #3/0 insulated ground

3) Each firestop system assembly shall be identified by Manufacturer and Product, as well as UL system number for that particular location.

(a) Example #1 – Firestopping Sleeve: EZ-Path Series 22, UL System W-L-3255

(b) Example #2 – Backbox in Fire-Rated Wall: Specseal Power Shield, UL System QCSN/CLIV.R14288

4) Each pull box and access panel shall be identified by size and height above finished floor.

(a) Pull box Example: Pull box 8” x 24” x 40” approximately 12’ AFF.

b) Include pathway systems (conduit, cable tray, auxiliary supports, etc.) and other Common Work on the same shop drawings for Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

D. Project completion submittal

1. As Built Drawings:

a) Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS.

2. Keys – Supply two copies of every key as required for pull boxes, junction boxes, and access panels.

3. Pictures of firestop system assembly.

1.07 QUALITY ASSURANCE

A. Install Work in strict conformance with manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA 1.

B. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL (DIR). Firestopping products shall bear this classification marking.

2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:

a) FM Research, approved in accordance with FM 4991.

b) Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, installers shall have current FIT Level 1 certification.

PART 2 - PRODUCTS AND MATERIALS

2.01 GROUNDING AND BONDING

A. Refer to drawings and Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS for grounding and bonding requirements.

2.02 PATHWAYS FOR ELECTRONIC SECURITY

A. Hangers and Supports

1. Cable hook supports (J-hooks)

a) Basis of design

1) Above ceiling: Eaton Corporation PLC; B-Line series BCH21, BCH32, BCH64

b) Other acceptable manufacturers

1) Hilti, Inc

2) MonoSystems

3) nVent Electric PLC; Caddy

4) Panduit Corporation

5) Substitution: See Division 01 - PRODUCT REQUIREMENTS.

c) Description

1) Non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable.

2) Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

3) Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations.

4) Be open for easy lay-in and removal of cabling.

5) Be designed so the mounting hardware is recessed to prevent cable damage.

6) Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653/A653M. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3

7) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304

8) Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

9) Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.

2. Cable supports (saddle or loop)

a) Basis of design

1) Above ceiling: nVent CADDY CAT 425, 425A6

b) Other acceptable manufacturers

1) nVent Electric PLC; Caddy

2) Substitution: See Division 01 - PRODUCT REQUIREMENTS.

c) Description

1) Non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable.

2) Suitable for air handling spaces (plenum)

3) Adjustable strap allows for multiple support sizes to reduce inventory.

B. Conduit and Backboxes

1. Conduit

a) Manufacturers

1) Refer to Division 26 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS for list of Manufacturers.

b) Description

1) Refer to Division 26 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS for product and material information. Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

c) Conduits routed within the building as connection to outside devices (exterior to the footprint of the building) shall be rigid metal (RMC) or intermediate metal conduit (IMC) at the point it enters the building, emerges from an exterior wall or ground floor slab to the final Equipment Room termination/transition point.

1) If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated.

d) For interior devices (and devices on the face of exterior walls) Electrical metallic tubing (EMT) with compression connectors shall be used where concealed in walls, above ceiling, and exposed or concealed in equipment rooms.

e) Unless specifically identified on the Security drawings, flexible conduit shall not be used.

f) Conduits shall be dedicated to specific sub-systems (i.e. video cabling shall not be installed in any other sub-system conduit, such as access control, intrusion detection, fire alarm, etc.).

g) Provide conduit as indicated on the Drawings or required by this Specification.

1) Minimum conduit size for Category cabling shall be: 3/4 inch for interior locations and 1 inch for exterior locations (such as devices at light poles and gates).

2) Provide a polypropylene or monofilament plastic line with not less than 200 lb tensile strength in each conduit.

3) Permanently mark or tag each conduit at the source and inside each pull box, identifying it based on specific subsystem (Access Control, Intrusion Detection, etc) and far-end destination. Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.

2. Outlet Boxes

a) Basis of design

1) Interior stud walls: Hubbell Incorporated; RACO 258/259

2) Plenum ceilings: Hubbell Incorporated; RACO 239

3) Interior 6 inch or 8 inch deep masonry walls: Hubbell Incorporated; RACO 695 (single-gang), 696 (dual-gang)

4) Exterior walls (weatherproof): ABB Ltd; Thomas & Betts IHD3-3 (single-gang), 2IHD5-3 (dual-gang)

b) Other acceptable manufacturers

1) ABB Ltd; Thomas & Betts, Steel City

2) Emerson Electric Company; Appleton

3) Hubbell Incorporated; RACO

4) Randl Industries, Incorporated

c) Description

1) Interior stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inch width by 4-11/16 inch height by 2-1/8 inch depth, with a raised cover/extension ring with depth matching wall gypsum board(s) thickness.

2) Plenum ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inch width by 4 inch height by 2-1/8 inch inch

depth, with a raised cover/extension ring with depth matching ceiling tile thickness.

3) Interior 6 inch or 8 inch deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inch deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inch deep.

4) Weatherproof: Aluminum die cast, weatherproof box with 1 inch conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inch deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inch deep.

3. Junction Boxes

a) Basis of Design: Hoffman A6N64 (or larger)

b) Other acceptable manufacturers

1) Hoffman

2) Hubbell/Wiegmann

3) NEMA Enclosures

c) Descriptions

1) Location: in accessible ceiling space above access controlled doors

2) Minimum Size 6 inch x 6 inch x 4 inch deep, or as noted on drawings/details, with hinged cover

3) NEMA 1 rating

4. Pull Boxes

a) Acceptable manufacturers

1) Hoffman

2) Hubbell/Wiegmann

3) NEMA Enclosures

b) Descriptions

1) Interior use only

2) mounted in Conveniently Accessible Locations.

3) NEMA EN 10250 listing: NEMA 1

4) Refer to Execution section for sizing requirements.

5) Shall be keyed

2.03 SURFACE RACEWAYS

A. Manufacturers

1. Hubbell Incorporated
2. Legrand SA; Wiremold
3. Mono-Systems Incorporated
4. Multilink
5. Panduit Corporation
6. Substitution: See Division 01 - PRODUCT REQUIREMENTS.

B. Description

1. Refer to Division 26 for specific product and material information. Where a conflict exists between Division 26 and Division 28 the more stringent requirements shall apply.
2. Raceways shall be sized per the quantity and size of the installed cables, plus 50% spare capacity. Minimum cross-sectional area shall be 1 inch.
3. Single gang and double gang surface boxes shall be a minimum of 2-1/2 inch deep.
4. Color shall be as directed by the Architect.

2.04 UNDERGROUND DUCTS AND RACEWAYS

A. General

1. Refer to Division 26 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS and Division 27 - UNDERFLOOR RACEWAYS FOR COMMUNICATIONS SYSTEMS for additional requirements. Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.

B. Handholes - for exterior, in-grade applications

1. Basis of Design: Hubbell Incorporated; Quazite PG
2. Other Acceptable Manufacturers
    a) Armorcast Products Company
    b) CRH PLC; Oldcastle Infrastructure
    c) MacLean Highline
    d) NewBasis
    e) Substitution: See Section 01 6000 - Product Requirements
3. Description
    a) Size: 11 inch x 18 inch x 12 inch

b) Design Load: 22,500 lb, tier 22

c) For use with one or two conduits, 2 inch diameter and smaller are installed.

d) Construction: Polymer Concrete with straight side with open bottom

2.05 SLEEVES AND SLEEVE SEALS

A. Sleeves in unrated barriers

1. Manufacturers

a) Refer to Division 26 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS for list of Manufacturers.

2. Description

a) Nylon bushings at cable entry and exit, UL listed for plenum (UL 2043)

b) Conduit waterfall at areas where cables exiting sleeve will be damaged from pinch point or over bending. Panduit Corporation CWF400 or equal.

B. Sleeves in acoustical barriers

1. Basis of Design: Specified Technologies, Incorporated 33NEZ

2. Other Acceptable Manufacturers

a) 3M

b) Hilti Corporation

c) Substitution: See Division 01 - PRODUCT REQUIREMENTS.

3. Description

a) For use in place of conduit sleeves through walls of noise critical spaces.

b) Plenum Rated (to UL 2043)

c) Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.

2.06 ACCESS PANELS

A. Manufacturers

1. Activar/J.L Industries

2. Acudor Products

3. Alfab/Barco

4. Elmdor Products

5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Williams Brothers
9. Wind-lock
10. Substitution: See Division 01 - PRODUCT REQUIREMENTS.

B. Description

1. Where pull boxes are required above inaccessible ceiling spaces, or for other required conditions, provide an appropriately sized access panel.
2. Steel access doors and frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
    a) Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
    b) Frames: 16-gauge steel, with a 1 inch wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
    c) For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch wide exposed perimeter flange and adjustable metal masonry anchors.
    d) For gypsum wallboard or plaster: perforated flanges with wallboard bead.
    e) For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
    f) Flush panel doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
    g) Fire-rated units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
3. Locking devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
4. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.07 FIRE STOP SYSTEMS

A. Basis of design

1. Barrier penetration: Specified Technologies Incorporated EZ-Path

2. Back boxes in fire-rated wall: Specified Technologies Incorporated SpecSeal Power Shield

3. Other applications: Specified Technologies Inc. - submit UL System documentation for each floor/wall type and product cutsheets for STI materials to be utilized.

B. Other acceptable manufacturers

1. 3M

2. Hilti

3. Substitution: See Division 01 - PRODUCT REQUIREMENTS.

C. Description

1. General

a) Refer to Division 07 - FIRESTOPPING for additional requirements. Where a conflict exists between Division 07 and Division 27 the more stringent requirements shall apply.

b) Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

2. Barrier penetration - for sleeves through a single penetration (wall or floor)

a) Minimum performance requirements: Shall meet testing requirements of ASTM E814 or UL 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

b) Shall meet or exceed the ratings of the wall or floor that it penetrates.

c) Shall be a prefabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.

d) Allows the installation and removal of cables without the need to remove or add materials.

e) Used to seal penetrations of cables through fire rated partitions.

3. Back boxes in fire-rated walls

a) Used to seal backboxes in fire rated partitions.

b) Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with

the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.

c) Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

4. Other applications

a) For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.

b) Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

2.08 SECURITY FASTENINGS

A. Except in equipment rooms, exposed securing screws shall be stainless steel, center pin torx security screws. Security Fasteners: A maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Holo-Krome; a Danaher Corporation.
2. Safety Socket Screw Corporation.
3. Tamper-Pruf Screws, Inc.
4. Textron Inc.

2.09 IDENTIFICATION FOR COMMON WORK FOR ELECTRONIC SECURITY

A. Label Printers

1. Manufacturer

a) Aptiv PLC; HellermannTyton

b) Brady Corporation

c) Brother International Corporation

d) Epson Labelworks PX

e) Newell Company; DYNMO

f) Panduit Corporation

g) Substitution: See

2. Description

a) Refer to additional requirements in Part 3.

b) Refer to individual sections for additional identification requirements for work.

PART 3 - EXECUTION

3.01 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

A. General

1. Refer to Electrical Division 26 for specific installation requirements.
   a) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
2. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
3. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
4. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at each end of pull cord.
5. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate pathways with other trades prior to installation.
6. Pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
7. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 ft.
8. Store and keep dry products in original container in a climate controlled environment until installation is to occur.
9. Install pathways:
   a) So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
   b) So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
   c) So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
   d) So that the maximum allowable pulling tension is not exceeded.

e) To meet the requirements of the structure and the requirements of other Work on the Project

f) To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

g) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.

h) Parallel or perpendicular to building lines or column lines.

i) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

10. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall not be used to attach cables to cable supports.

11. Provide adequate pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for. Any deviation from this will not be accepted.

    a) At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports.

    b) At no point shall cables come in contact with, be supported by, or attach to building structures or supports.

12. Provide appropriately sized sleeves where cables (supported by J-hooks) are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 40% of the cross-sectional area is utilized by the cabling to be installed.

13. Suspended cables shall be installed with at least 3 inches of clear vertical space above the ceiling tiles and support channels (T-bars).

14. Waterproofing

    a) Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.

b) Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

15. Cutting and Patching

a) Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.

b) Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.

c) Patch around all openings to match adjacent construction.

d) Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.

e) Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

f) After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

16. Mounting Heights

a) Mounting heights for equipment and devices requiring operational access shall conform to ADA Standards.

b) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.

c) Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.

d) Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

17. Painting

a) Refer to Division 09 Section “Painting” for painting requirements.

b) Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and

methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.

1) If painting happens after cabling has been installed, cabling shall be masked off or otherwise protected so that cables are not painted. Paint on cables degrades the cable over time. PAINTED CABLES SHALL BE REPLACED with no additional cost to the Owner.

c) Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.

d) Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

e) Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

f) Provide touch-up paint as required by specification sections in this Division.

18. Fastenings

a) Fasten equipment to building structure in accordance with the best industry practice.

b) Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

c) Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1) To Wood: Fasten with lag screws or through bolts.

2) To New Concrete: Bolt to concrete inserts.

3) To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4) To Existing Concrete: Expansion anchor fasteners.

5) To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.

6) To Light Steel: Sheet metal screws.

7) Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

d) Where weight applied to building attachment points exceeds 300 lb, coordinate with and obtain the approval of Architect and conform to the following as a minimum:

1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

e) For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

f) Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces.

B. Access to pathways and associated equipment

1. Locate pull boxes, junction boxes and fire-rated pathway devices to provide easy access for operation, service inspection and maintenance.

2. Provide an access door/panel where equipment or devices are located above inaccessible ceilings. Where access doors/panels are necessary but not shown on the plans, coordinate type and location with Architect and Design Consultant through an RFI.

3. Maintain code required clearances and clearances required by manufacturers.

C. Cable Distribution

1. For low-voltage cabling (that provides power at 70v or less), refer to section above.

D. Conduits

1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.

2. Adequate access shall be available where cables enter conduits.

3. Bond and ground metallic conduits and boxes in accordance with TIA-607.

4. Install conduits in the most direct route possible, running parallel to building lines.

5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.

6. Conduits which enter Telecommunications or Security/Equipment rooms shall extend 3 inches AFF or through the wall.

7. Flexible conduits may only be used where specifically allowed by these Contract Documents.

    a) Where indicated, flexible conduit sections shall be less than 20 ft in length.

8. No continuous section of a conduit may exceed 100 feet without a pull box.

9. No more than (2) 90° bends, or equivalent will be allowed between pull boxes.

    a) Each and any offset shall be considered a 90° bend.

    b) A pull box is required wherever a reverse bend is installed.

10. The minimum bend radius for conduits is:

    a) (6) times the inside diameter for 2 inches conduits or less.

    b) (10) times the inside diameter for conduits greater than 2 inches.

11. Conduits shall contain no electrical condulets (also known as LBs). Conduit Bodies serving an Electronic Security cable shall meet cable's bend radius requirements.

12. Underground Conduit Requirements

    a) Cabling and pathways serving devices exterior to the building, such as emergency phones/towers and security cameras.

    b) Requirements

        1) Refer to applicable details on drawings for illustrative requirements.

        2) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.

            (a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include

product information in pre-construction submittals. In general, handholes are NOT to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.

(b) These underground conduits shall stub directly into the serving Communications Room/Equipment Room. If not, extend cabling within the building in IMC or RMC to the serving Equipment Room.

3) Approved conduit types:

(a) When routed below slab-on-grade or outside the footprint of the building:

(1) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12 inch below grade. If PVC is installed, also install tracer wire.

(2) All vertical and horizontal bends and areas subject to vehicular traffic (loads) such as parking lots and roadways shall be RMC or concrete-encased PVC.

E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.

a) Where possible offset to next stud cavity, with a minimum of 6 inch separation.

2. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.

3. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. Pull Boxes

1. Pull boxes shall be placed in Conveniently Accessible locations.

2. Coordinate the location and installation of all Pull Boxes to ensure adequate access is provided.

3. Pull boxes above an accessible ceiling shall:

a) Be aligned directly over the ceiling grid to allow access.

b) Be installed with a minimum of 3 inch clearance to ceiling grid and tiles

4. No directional changes shall be allowed in pull boxes. Conduit shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.

5. Size pull boxes according to the following chart:

TABLE 1: PULL BOX SIZING

CONDUIT TRADE SIZE	WIDTH	LENGTH	DEPTH	WIDTH INCREASE FOR ADDITIONAL CONDUIT (OF SAME SIZE)
¾" OR SMALLER	4"	4"	2-1/8"	NOT APPLICABLE
1"	4"	16"	3"	2"
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	28"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	6"

3.02 LABELING

A. Labeling Installation

1. Labels are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on or for:

a) Firestopping systems: For wall and floor penetrations, label on both sides. See Firestopping later in this section.

b) Pathways (e.g., conduit etc.) installed under this work.

1) Label all conduit with "SECURITY". Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.

2) For wall stub-up locations, label overhead only.

3) For conduits greater than 10 ft, label both ends of conduit with far end location and Room/Number.

(a) Example – "Security to Panel 1 in Equipment Room 127".

4) For conduits that stub directly up or into an Equipment Room, label both ends of conduit.

(a) Example: underslab/ground conduit from Equipment Room 127 to Camera #13 attached to an exterior lightpole shall be labeled as follows:

(b) Conduit stub-up location in Equipment Room 127 – "Security to Camera #13".

(c) In the lightpole/junction box, immediately adjacent to serving conduit – "Security to Equipment Room 127".

5) All pull boxes and junction boxes for Security shall be labeled "SECURITY PULL BOX" on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.

(a) Conduits entering and exiting all pull boxes and junction boxes shall be labeled with their destination/room number – ie "To Security Camera #17 in Room 114".

c) In general, the label is to be provided and installed by whomever installed the item that is being labeled.

d) Refer to individual Division 28 sections and to the drawings for additional information on labeling requirements.

3.03 FIRESTOPPING

A. General

1. Provide fire resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.

2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas, or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.

a) Assume all floors are fire-rated, unless otherwise noted.

b) Also install fire stops at any other locations indicated in the Specifications or Drawings.

3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:

   a) Fire stop Manufacturer

   b) Installer and company

   c) Date installed.

   d) UL system number with all relevant ratings indicated.

4. Include labels in each equipment room in which one or more fire-rated walls is installed. Provide a 2 inch letter stencil label on the inside of the room to indicate rating for each barrier.

5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor, or partition around conduits in accordance with system listing and manufacturer’s instructions.

C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.

2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays, or other equipment related to the electronic security systems not to be reused.

3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.

D. Fire-Rated Pathway Device

1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors, or partitions.

2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.

3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer’s recommendations.

4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.

5. Secure wall plates (where required) to devices per the equipment manufacturer’s recommendations.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Confidentiality Notice

B. System Description

C. Personnel and Contractor Qualifications

D. Warranties

E. Coordination

F. Identification/Labeling

G. Start-up of Systems

H. Project Close-Out Instructions

I. This parent section pertains to subsections 281001 through 283999.

1.02 RELATED SECTIONS

A. General provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections.

B. Division 26 ELECTRICAL

C. Division 27 COMMUNICATIONS

D. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

E. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

F. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

G. Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

H. Section 28 1015 - TELECOMMUNICATIONS REQUIREMENTS FOR ELECTRONIC SECURITY

I. Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

1.03 ACRONYMS AND DEFINITIONS

A. Electronic Security Contractor (ESC) – The primary Contractor of this and all related specification sections (281000 through 283999). The ESC is also responsible for fully coordinating all Electronic Security System requirements with other Divisions and sections, such as power, grounding/bonding, fire alarm, and pathways/other common work.

B. Equipment Grounding Conductor – as defined in the NFPA 70, the conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system ground conductor or to the grounding electrode conductor, or both.

C. Equipment Room – A secured room either exclusively reserved for Security System headend equipment, or shared with other low-voltage systems such as Telecommunications headend equipment, Fire Alarm panels, etc.

D. Final Acceptance Review – the final site observation by Design Consultant; refer to Submittal paragraph (in Part 1 of this Section) and Project Close-Out Instructions (in Part 3 of this Section) for additional information / requirements.

E. System – short for Electronic Security System, Work governed by this and related documents.

1.04 REFERENCE STANDARDS

A. 49 CFR 1520 - Protection of Sensitive Security Information; Current Edition.

B. ASIS PAP - Physical Asset Protection; Current Edition, Including All Revisions.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 731 - Standard for the Installation of Premises Security Systems; current edition.

E. Texas Government Code Sec. 418 - Emergency Management; Online Edition.

F. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

G. TIA-942 - Telecommunications Infrastructure Standard for Data Centers; Current Edition.

H. UL (DIR) - Online Certifications Directory; Current Edition.

1.05 CONFIDENTIALITY NOTICE

A. Electronic Security System Work is confidential in nature. All drawings and relevant specification sections are considered confidential information and shall

remain secure. Track all physical copies of Electronic Security System documents, restrict document access to those working directly on the project; properly dispose of the physical documents when no longer needed. Share and/or restrict access of electronic documents to only those working directly on the project having "a need to know".

1. Proper disposal of physical documents means that they are crosscut shredded, incinerated, or pulped such that there is reasonable assurance the hard copy materials cannot be reconstructed.

2. These confidentiality requirements are a minimum. Follow local, state, and federal laws where more stringent. For projects in the State of Texas, failure to comply may result in a breach of Texas Government Code Sec. 418 .181.For aviation projects, failure to comply may result in breach of 49 CFR 1520 - Protection of Sensitive Security Information.

1.06 SYSTEM DESCRIPTION

A. Provide a complete and functioning electronically controlled physical security system ("Electronic Security System"), and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

1. All Electronic Security Systems shall have a level of immunity to power interruptions, be time synchronized, and employ a level of redundancy or failure recovery so as to minimize the loss of data, monitoring, and control.

2. For data center projects, the Electronic Security Systems shall meet the redundancy and failover requirements set forth by its classified Tier (I-IV) level as defined by TIA-942.

B. Specification sections 281000 through 283999, and Drawings numbered with prefixes TY, generally describe these systems, but the scope of the Electronic Security System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Fire Alarm System Drawings and Specifications; and Addenda.

C. The general scope includes, but is not limited to, these systems:

1. Provide a complete and functioning Electronic Security System comprised of the following subsystems:

a) Access Control System

b) Video Intercom System

c) Intrusion Detection System

2. Coordination with the Owner 's IT Department to connect all necessary Electronic Security equipment onto the Owner 's Local Area Network.

3. Provide time synchronization across all server and PC controlled and monitored Electronic Security System sub-systems. Where available, utilize the Owner's time server for time reference.

D. The Work also includes, but is not necessarily limited to, the following:

1. Conduit, backboxes, pull boxes, firestopping, and other pathways necessary for the completion of all Electronic Security Systems – installed per Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY; if another Sub-Contractor is providing the pathways/common work (as coordinated with the Prime Contractor), the Project Manager and/or Quality Control Specialist of this section shall coordinate and inspect the installation of all pathways/common work with that Sub-Contractor.

2. Cabling between the Electronic Security headend equipment and field devices, and between multiple Equipment Rooms.

3. Full build-out of Equipment Rooms, including all terminations, patch panels, patch cords, cabinets, equipment racks, ladder rack, backboards, etc. Where equipment rooms and pathways are shared with other systems, such as Telecommunications and/or Audio Video, coordinate Division of Labor for shared infrastructure.

4. A grounding/bonding system, as described in these construction documents, required by equipment manufacturers, and referenced codes and standards.

5. Appropriate cable supports as required by these construction documents, such that all cabling external to Equipment Rooms is either installed in conduit or supported via J-hooks or cable tray every 48 inches to 60 inches .

6. For cabling in Equipment Rooms, cable shall be supported every 18 inches for both horizontal and vertical routing, by either ladder-type cable tray or d-rings on backboards.

a) This is not a requirement for telecommunications cabling required for Work under this Division. Refer to Section 27 1000 - STRUCTURED CABLING for pathway requirements within Equipment Rooms.

7. Testing, labeling, and documentation of cables and hardware installed under this Division.

E. Prepare and submit shop drawings, testing reports, as-built drawings, and cabling documentation in a timely manner to conform to all project schedules and timelines.

1. Submittals are a crucial requirement to a successful project. No work may begin until Pre-Construction Submittals have been approved by the Design Consultant.

2. Incomplete submittals, including submission of unedited bid drawings as shop drawings, will be immediately rejected and not reviewed.

3. The first pre-construction Submittal shall be of such detail and thorough enough to demonstrate to the Design Consultant and Owner that the ESC understands the project requirements and for installers to have sufficient information to complete construction in accordance with the contract documents.

    a) The project schedule is dependent upon the first pre-construction submittals being thorough enough that only minor edits (if necessary) will be required to be resubmitted.

4. Accurate Record Drawings and other close-out documentation are integral to the Owner's use and maintenance of the System, and are to be submitted prior to the Final Acceptance Review.

1.07 SUBMITTALS

A. Refer to requirements in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS. At a minimum, follow these additional requirements:

1. Pre-Bid Submittal (due at the questions deadline during the bid window)

    a) Substitution Request for any one of the following:

        1) Product Substitutions

        2) Alternate Personnel Qualifications

        3) Contractor Qualifications (for ESCs wishing to be added to the Pre-qualified Contractors list)

2. Bid

    a) Additional cost to extend the warranty coverage from 1 year to 3 years.

3. Pre-Construction Submittal

    a) Submit the following information for Electronic Security Work together (Sections 281000 through 283999) at the same time, with information grouped in the following categories, then identified by section and in the exact order of the specifications:

        1) Cover Page, which includes name of ESC and contact name, phone, and email of the following:

            (a) Quality Control Specialist

            (b) Project Manager

        2) Division of Labor

(a) Indicate any sub-systems – such as Common Work (conduit, backboxes, etc.), cabling, structured cabling – that will either be provided by a Sub-Contractor to the ESC or to the Prime Contractor. Indicate the company name that is provided each sub-system.

3) Schedule

(a) Gantt chart format; coordinate with Prime Contractor as needed.

4) Equipment List

(a) Typed list in the following format:

(1) Product name / type

(2) Manufacturer

(3) Model name

(4) Model number

(b) Separated by specification section and in the exact order as listed in the specification sections.

5) Cut Sheets

(a) Separated by specification section and in the exact order as listed in the specification sections.

6) Shop Drawings

(a) Scaled floor plans, at not less than 1/8" = 1'-0" scale, to identify the following:

(1) Room names and numbers

(2) Door numbers (to match the Architect's Door Schedule)

(3) Conduit, firestopping, cable tray, and other common work locations, sizes and routing, as required by Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY.

(4) Cable type, quantities, routing, and approved identification,

(5) Equipment Room locations and serving areas,

(6) Dimensioned device locations and approved identifiers,

(7) Where the System controls electronic door hardware, identify type (of electronic door hardware) and voltage for each door.

(b) Enlarged scaled floor plans and elevations, at not less than 1/4" = 1'-0" scale, of Equipment Rooms, showing 3 feet of clearance space in front of all panels and wall-mounted racks/cabinets and 3 feet of clearance space in front of and behind all floor-mounted racks/cabinets.

(c) Details of the following:

(1) Termination, or pin-out, details of multiple or multi-conductor cables at the Device and Equipment ends for each type of device.

(2) Riser, block, functional, and grounding/bonding diagrams for all systems and sub-systems.

7) Electronic Security Network Requirements:

(a) As part of Pre-construction Submittal, include a spreadsheet in both PDF and Excel file formats with the following information for all new Electronic Security equipment that will be connected to the building's Electronic Security Network:

(1) Room Number of Equipment Location (Example: Room 113)

(2) Equipment Type (Example: POE Camera)

(3) Manufacturer (Example: Axis)

(4) Model Name (Example: 1080p Indoor Network Camera)

(5) Model Number (Example: P3346-VE)

(6) Mac Address (Example: 14:A9:9F:0D:3D:16)

(7) Serving Electronic Security Equipment Room (Example: MDF 120)

b) Refer to individual sections in this Division for additional Pre-Construction Submittal requirements.

4. Preliminary Project Completion Submittal

a) A minimum of 1 week prior to the Final Acceptance Review, submit Preliminary Project Completion Submittal, to include the following documentation:

1) Resubmit approved Pre-Construction Submittals of the following, updated to reflect all changes during construction:

(a) Equipment List

(b) Cut Sheets

(c) Preliminary Record Drawings – based on drawings kept on site.

(1) Scans of on-site drawings are acceptable, provided notes and minor changes are legible

(2) These drawings shall include the actual installed device and cable IDs that correspond to submitted test results.

2) Submit the following additional items (as part of each sub-system):

(a) Operation and Maintenance Manuals

(b) Test Results for all sub-systems.

(1) Device and cable IDs shall correspond to submitted Preliminary Record Drawings.

3) And additional items as required in other Division 28 Electronic Security specification sections.

b) Refer to the Project Close-Out Instructions in Part 3 of the section for additional information and requirements.

5. Final Project Completion Submittal

a) After Final Acceptance Review and before Substantial Completion:

1) Address all Punch List items generated from Final Acceptance Review,

2) Retest effected items

3) Conduct Owner Training and deliver any spare parts / physical items to Owner.

b) Submit the following items:

1) Cover Page – to include ESC company name and contact information for Warranty issues

2) (Updated) Equipment List (with length of manufacturer warranty that extends beyond 1 year), Cut Sheets, Operation & Maintenance Manuals, and Test Results

3) (Updated) Record Drawings, in AutoCAD and searchable PDF file formats

4) Spare Parts / Physical Media Confirmation – included scanned PDF of written confirmation from Owner that all spare parts and physical media were furnished to Owner at the time of Owner Training.

5) Manufacturer Warranty Information and Certificates

c) Update Electronic Security Network Requirements spreadsheet with any changes made during installation. Include PDF and Microsoft Excel file formats.

d) Refer to the Project Close-Out Instructions in Part 3 of the section for additional information and requirements.

e) Refer to individual sections in this Division for additional Project Completion Submittal requirements.

1.08 QUALITY ASSURANCE

A. Contractor Qualifications

1. Electronic Security Contractors (ESC)

a) For other Contractors wishing to be pre-qualified to bid and perform this Work, submit the following information for review and consideration by Owner and Design Consultant prior to the inquiry (questions) deadline before Bid (Pre-Bid Submittal).

1) ESC shall have a minimum five (5) continuous years in the business of integrating and/or installing Electronic Security equipment including but not limited to the systems identified with the Summary of Work paragraph of this Section.

2) Prior to bidding this project, the ESC shall be a certified installer by the equipment manufacturers whose products shall be incorporated into this project. Post-award certification will not be accepted.

3) ESC shall maintain certification by the manufacturers thru the duration of the warrantee period.

4) When requested, provide a list of projects (no less than 3) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

5) ESC shall be a direct Contractor to the project's Prime Contractor, and shall not be Sub-Contractor under Division 26 or any other Division of Work.

b) ESC shall maintain a service facility or warehouse that will stock spare parts of all system components not readily available (within 24 hours) through local distribution channels.

B. Personnel Qualifications

1. Provide and maintain a Quality Control Specialist on staff as a full-time employee at all time. This person shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant. This person shall conduct weekly inspections and approve all submittals and work performed. This personal shall possess one or more of the following:

   a) Current ASIS Physical Security Professional (PSP) or Certified Protection Professional (CPP)

   b) An individual with substantial industry experience (10+ years); submit a copy of this person's resume with Pre-Construction submittals and whenever requested.

2. Provide and maintain a qualified Project Manager, who shall be on-site at all times Work in this (and Related Sections) is being conducted and shall attend all scheduled project meetings. This person shall possess one or more of the following:

   a) Current ASIS PSP or CPP certification.

   b) Technology-related degree from an ABET accredited institution.

   c) An individual with significant industry experience as a project manager (5+ years); submit a copy of this person's resume with Pre-Construction submittals and whenever requested.

3. Any additional personnel that will be physically installing any part of the Electronic Security System shall, at a minimum, be in good standing as one of the following:

   a) NJATC Installer Technician

   b) NICET Level III Technician (audio, automation, or video)

   c) Or be assigned to work under the direct supervision and direction of a person holding said certifications.

4. In addition, where required by state and local jurisdictions, any personnel working on-site shall be licensed, for security work or other work as required by this and related sections, and proof of licensure shall be submitted.

   a) For work in the State of Texas, any personnel conducting Work on-site under this and related sections shall be duly licensed by the Texas Department of Public Safety Private Security Bureau for the duration of the project. Submit proof of licensure as noted in Submittal Section.

5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.

6. Alternate qualifications may be considered. Provide requested alternate considerations prior to Bid in accordance with the Substitution Request instructions in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS.

1.09 WARRANTIES

A. Per Division 01, and unless otherwise noted in Division 28 specifications, ESC shall warrant all work to be free of defects in workmanship and materials for a period of 1 year from the date of Substantial Completion.

B. ESC shall provide a point of contact (phone number) for all warranty and service calls, such that the ESC will respond and be on-site within 12 hours of the first call, and the repair completed to the satisfaction of the Owner within 36 hours of arrival on site.

1. For issues not properly resolved within this timeframe or those that are unable to be resolved in the field, ESC may elect from the following (subject to approval of the Owner):

a) Provide temporary/loaner equipment of comparable function until such time that the component can be fixed or replaced.

b) Reimburse the Owner for additional security staff necessary to cover the down time of that part of the System.

C. All Warranty Work shall be completed by factory-certified technician(s) of the component(s) being address.

D. ESC shall visit the job 30 days prior to the end of the 1-year warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

1.10 COORDINATION

A. The locations of outlets, devices, panels, equipment racks and other equipment indicated on the Drawings are approximate and are understood to be subject to such minor revision as may be found necessary or desirable at the time the work is installed in order to meet field conditions, coordinate with modular requirements of ceilings, simplify the work, establish sight lines for cameras, improve visibility for interactive security devices, or for other legitimate causes.

B. Exercise particular caution with reference to the location of outlets, devices, control panels, switches, etc. Verify with the Architect the exact location and mounting height of outlets, devices and equipment not dimensionally located on the Drawings.

C. The Drawings show only the approximate locations of outlets and devices, and, if shown, general run of raceways. Any significant changes in location of outlets, devices, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Except for unforeseeable extenuating circumstances, modifications shall be made at no additional cost to the Owner.

D. Comply with NFPA 731 and ASIS PAP.

E. Camera, door, and device tags in the form of alpha/numeric characters are used where shown to indicate the designation numbers for identification purposes at the equipment panels and/or patch panels. Show the actual camera, door and device numbers on the as-built Record Drawings, on the associated typed field labels and in the printed and computer readable cabling and device schedules. Submit sample camera, door, and device information tags (proposed labeling scheme).

F. The drawings do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Under no circumstances shall 40 percent raceway fill be exceeded, regardless of the type of cabling installed.

G. Provide the correct cable type and quantity as required by the indicated outlets, devices, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NFPA 70 and TIA-569.

H. Cabling shall be installed complete and unspliced from field device termination to headend termination, unless otherwise noted.

I. Cabling installed in Damp or Wet Locations (as defined by the NFPA 70) shall be wet-rated / listed for installation in a Wet Location.

1. Underground pathways for devices exterior to the building shall stub up directly in the serving Equipment Room; if conduits stub up elsewhere in the building, a junction box is required in an accessible ceiling location and the cabling shall transition from wet-rated to plenum- or riser-rated cabling (per Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY and Section).

J. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment.

1. At a minimum, coordinate the following with the Division 26 Contractor:

a) All electrical circuits serving Electronic Security System equipment shall be supplied with an Equipment Grounding Conductor for each circuit.

b) All electrical circuits serving Electronic Security System equipment shall have dedicated neutrals (no shared neutrals between branch circuits).

K. Within two weeks after the Notice to Proceed, schedule a meeting with the Owner's IT and Security staff to coordinate network requirements and programming of the Electronic Security Systems.

L. Coordinate sustainable requirements per Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS.

PART 2 - PRODUCTS AND MATERIALS

2.01 NOT USED

A. Refer to individual Electronic Security System sections for product requirements.

PART 3 - EXECUTION

3.01 IDENTIFICATION / LABELING

A. General Requirements

1. The inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.
2. Required UL (DIR) labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

B. Refer to individual Electronic Security System sections for additional requirements.

3.02 START-UP OF SYSTEMS

A. Prior to system start-up, conduct or ensure the following safeguards:

1. Check all electrical circuits of the various devices for proper wiring polarity, grounding, and activation.
2. Verify that equipment is effectively bonded and grounded to earth.
3. Ensure all Equipment Rooms are properly conditioned and free of dust or other contaminants.

3.03 ELECTRONIC SECURITY NETWORK COORDINATION

A. Coordinate the following with the Owner's IT and Security Operations departments:

1. Quantity of additional data ports (PoE and non-PoE) required at each Telecommunications Room/Rack.
2. IP / Mac Addresses of all new Electronic Security equipment that will be connected to the building's Electronic Security Network.
3. Additional bandwidth requirements of the new Video Surveillance cameras from each Electronic Security Equipment Room.
4. Additional storage requirements of the new Video Surveillance cameras to be recorded onto the Owner's existing NVR / Storage Server(s).

B. As part of Pre-construction Submittal, include a spreadsheet with the following information for all new Electronic Security equipment that will be connected to the building's Electronic Security Network:

1. Room Number of Equipment Location (Example: Room 113)
2. Equipment Type (Example: POE Camera)
3. Manufacturer (Example: Axis)
4. Model Name (Example: 1080p Indoor Network Camera)
5. Model Number (Example: P3346-VE)
6. Mac Address (Example: 14:A9:9F:0D:3D:16)
7. WAN Access Required? (Example: No)
8. PoE / PoE+ (Example: Yes, PoE+)
9. Anticipated Bandwidth (Example: 133 kbps)
10. QoS (Quality of Service) (Example: Medium)
11. Serving Electronic Security Equipment Room (Example: MDF 120)

3.04 PROJECT CLOSE-OUT INSTRUCTIONS

A. Functional Testing

1. Conduct and finish functional tests of all sub-systems, and integrated testing where applicable. Correct any and all functional issues prior to requesting the Final Acceptance Review by the Design Consultant.

B. Preliminary Project Completion Submittal

1. Submit the following at least 1 week prior to requesting the Final Acceptance Review:
    a) A copy of Pre-Construction Submittals updated with all changes made during construction.
        1) If changes noted on the jobsite work prints are readily legible, a scanned copy is sufficient at this time.
        2) Otherwise, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the

jobsite work prints onto these drawings. These changes shall be done electronically in BlueBeam*, AutoCAD or BIM software and saved to PDF format. Each sheet shall contain the ESC's name/logo and be identified as "Preliminary Record Drawing".

(a) *Final Record Drawings shall be created in AutoCAD or BIM software; annotated PDF drawings will not be accepted.

b) Detailed Test Reports of the following sub-systems:

1) UPS testing per Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

2) Grounding and Bonding per Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

3) CAT-6/6a (Fiber) Test results per Section 27 1000 - STRUCTURED CABLING.

4) Functional Test Reports per individual sections for the following:

(a) Access Control doors, locations, and devices

(b) Intrusion Detection

(c) Intercom Entry

c) Copy of the Operation and Maintenance Manuals for each specified piece of equipment.

C. Final Acceptance Review

1. Upon completion of all functional testing, request in writing a Final Acceptance Review; this is a final site observation by the Design Consultant. Give the Architect and Design Consultant at least seven (7) days' notice prior to the review. Make the request sufficiently enough in advance for the review to properly be scheduled and completed such that punch list items can be addressed before substantial completion.

2. State in the written request that the ContractorContractor has complied with the requirements for Substantial Completion.

3. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.

4. During the Final Acceptance Review, provide the following:

a) Services of the Project Manager, as identified in the Quality Assurance part of this Specification Section, and a minimum of two other technicians familiar with the project. The Project Manager shall facilitate the review and demonstration of the Electronic Security System and all sub-systems as requested by the Design Consultants.

1) Provide a minimum of two cell phones or radios to allow two-way communication between the headend or workstation location and a mobile technician to trigger various security alerts.

b) Ladders, lifts, and/or scaffolding as required to reach all cameras or other high-mounted devices.

c) Specific test equipment used during the Contractor's preliminary testing activities, and the services of qualified technicians to operate such test equipment.

1) Per individual sections, the Design Consultant may request the Contractor conduct random retesting to confirm the documented test results.

2) Refer to individual sections for exact requirements.

5. If the Contractor requests a Final Acceptance Review prior to completing the requirements of the Contract Documents, then provide reimbursement to the Design Consultant for time and expenses incurred for the visit.

6. Upon completion of the review, the Design Consultant will prepare a "punch list" of outstanding items not in compliance with the Contract Documents, to be completed or corrected for final acceptance.

a) Omissions on the "punch list" shall not relieve the Contractor from the requirements of the Contract Documents.

D. Punch List Completion

1. Complete all punch list items before Substantial Completion.

2. Retest affected items.

3. Update Preliminary Project Completion Submittal with all changes.

E. Project Completion Submittal

1. At the completion of the project, compile the following electronic files, divided into the following sub-folders:

a) Equipment List, in PDF and Microsoft Excel format, to include:

1) Specification Section number

2) Quantity

3) Manufacturer

4) Part Number

5) Serial Number

6) Manufacturer's warranty end date, if greater than 12 months after Substantial Completion

b) Cutsheets and Operation and Maintenance Manuals

c) Test Results and Cable Databases, in PDF and Microsoft Excel format

d) Record Drawings, in PDF and AutoCAD file formats

2. All products and submittals are to be in the exact order as these specifications.

3. Cutsheets and O&M Manuals are to be separate files identified by ## - Product Name – Manufacturer – Model.pdf, where ## is the sequential order of the product in that specification. Example (manufacturer and products may be different for this project):

a) 01 – Headend System – Lenel – OnGuard – 7.2

b) 02 – Server Software – Lenel – OnGuard – SWS-32ES

c) 03 – Workstation – Dell – Precision T3500

d) 04 – Controller – Lenel – Intelligent Dual Reader

e) 05 – Interface Module – Lenel – Dual Reader Interface Module

f) 06 – Power Supply – Altronix – Multi-Output Power Supply

g) 07 – Card Reader – HID – Multi-class Reader

h) 08 – (continue as needed)

4. Test Results and Cable Database requirements are to include the following:

a) Test Results to include PDF of passing Functional Test Report for each device, organized by sub-system. Refer to individual sub-sections for Functional Test Report requirements.

b) Cable Database requirements – refer to Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY and Section 27 1000 - STRUCTURED CABLING; these are to be submitted in PDF and Microsoft Excel file formats.

5. Record Drawings

a) Refer to Record Drawings paragraph in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS for additional requirements.

b) Record Drawings shall be updated versions of the approved Shop Drawings and shall meet all Shop Drawing requirements.

c) Record Drawings for each Electronic Security sub-system shall be provided with final cable routing and pathway routing noted.

1) J-hook / cable routing shall be indicated.

2) Conduit and pullbox routing and locations shall be indicated.

6. After Design Consultant makes comments on the Final Project Completion Submittal, incorporate changes and:

   a) Save a copy of these files onto the Workstations provided by the ESC.

   b) Forward updated Final Project Completion Submittal files to Owner. Include file path information for these updated files on the Workstations provided by the ESC.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. General Requirements

B. Low-Voltage Control and Power Cables

C. Telecommunications Cabling

D. Cable Identification Labels

1.02 RELATED REQUIREMENTS

A. Section 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

B. Section 27 1000 - STRUCTURED CABLING

C. Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

D. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

E. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

F. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

G. Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY

H. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

I. Section 28 1015 - TELECOMMUNICATIONS REQUIREMENTS FOR ELECTRONIC SECURITY

1.03 DEFINITIONS

A. Damp Location – as defined by the NFPA 70, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.

B. Electronic Security Contractor (ESC) – The primary Contractor of this and all related specification sections (281000 through 283999). The ESC is also

responsible for fully coordinating all Electronic Security System requirements with other Divisions and sections, such as power, grounding/bonding, fire alarm, and pathways/other common work.

C. Point of Entrance (Building Entrance) – as defined by the NFPA 70, the point within a building where the security cabling routed through a Wet Location emerges from an external wall, a concrete floor slab, or IMC/RMC.

D. Qualified Electrician – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved; in regards to this project, a Qualified Electrician is also licensed in the jurisdiction of the project to install electrical equipment (ie Journeyman or Master Electrician License).

E. Wet Location - as defined in the NFPA 70, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL (DIR) - Online Certifications Directory; Current Edition.

1.05 SUBMITTALS

A. Follow the requirements for submittals in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

B. Pre-Construction Submittal

1. Cut sheets shall contain the following information for each of the cables specified.

a) Manufacturers name and logo

b) Cable outside diameter

c) Number of conductors/strands in each cable and binder group

d) Gauge or strand thickness

e) Cable jacket material and rating (ie Plenum, Riser, wet-rated, etc.)

f) Maximum pulling tension

g) Jacket/Sheath color

h) Individual conductor or strand insulation colors (if applicable)

i) Minimum bend radius

1) During installation and post installation, if it differs.

2. Shop Drawings

a) Cable types required by this Section are to be identified on Shop Drawings for the following Electronic Security sub-systems: (separate 281010 Shop Drawings for this section are not needed)

1) Access Control

2) Intercom Entry Systems

3) Video Surveillance

4) Intrusion Detection

b) On the Shop Drawings for those Electronic Security sub-systems, show the proposed routing of all conductors and cables and the means of support:

1) Cable Tray

2) Conduit (solid line)

3) J-hooks every 48”-60” (dashed line), if allowed by Contract Documents

c) On the Shop Drawings for those Electronic Security sub-systems, include details showing the proposed termination and labeling (ID) scheme at each device and panel for each conductor/cable.

C. Preliminary Project Completion Submittal

1. Follow all requirements as specified in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

2. Update the approved shop drawings with any changes in cable routing, and submit as part of Preliminary Record Drawings per Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

3. Test Results

a) Include conductor/strand test as part of the Functional Test Reports for each Electronic Security sub-system.

4. Cable ID spreadsheet, saved in PDF and Microsoft Excel file formats, which shall include the following for each cable installed under this section:

a) Electronic Security Sub-System

b) Device Type

c) Device Identifier

d) Device Room Number (if not part of Device Identifier)

e) Headend Panel Identifier

f) Headend Panel Room Number (if not part of Headend Panel Identifier)

g) Cable Identifier

TABLE 1: CABLE IDENTIFICATION SPREADSHEET

Sub-System	Device Type/ID	Device Rm	Headend ID	Headend Rm	Cable ID
Access Control	Card Reader 01	Vestibule 101	ACP-01	IDF 114	AC-CR01-ACP01

D. Final Project Completion Submittal

1. Follow requirements as specified in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

2. Incorporate any changes from punch list items.

3. Include updated Cable ID spreadsheet.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL REQUIREMENTS

A. As part of a complete and functioning Electronic Security System and associated infrastructure, provide conductors and cables of appropriate type.

B. Conductor and cable requirements are unique to each manufacturer equipment / device. Unless otherwise noted, exact conductor and cable types are to be coordinated by the ESC to meet the requirements of the Electronic Security manufacturer.

C. Conductors and cables shall meet the following the requirements:

1. UL (DIR) Listed for the intended application.

a) Where areas above accessible ceilings are serving as plenum (air) return, and conductors/cabling is not installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Plenum (CMP) rated.

b) Where conductors/cabling are installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Riser (CMR) or Plenum rated.

c) Where conductors are/cabling are routed through a Damp or Wet Location, they shall be designed to withstand exposure to moisture and water and marked and listed as suitable for use in wet environments.

2. Cable type and conductor size/quantity shall be as recommended or required by the device/equipment manufacturer. Where the Contract Documents differ from manufacturer recommendations or requirements, notify the Architect requesting clarification.

3. Conductor sizes, if shown, are minimum. Where approved by the Design Consultant and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased to correspond with fill ratio requirements defined the NFPA 70.

4. Conductors and cables shall be shielded.

    a) Submit RFI for any manufacturer equipment that recommends non-shielded cable.

2.02 LOW-VOLTAGE CONTROL AND POWER CABLES

A. Basis of Design: See schedule on drawings

B. Manufacturers

1. Belden
2. Draka
3. General Cable
4. Tappan
5. West Penn Wire
6. Substitution: See Section 01 6000 - Product Requirements

C. Description

1. For 10 AWG through 24 AWG, and single conductors through 24-pair applications, as needed per project, submit product cutsheets concurrently with shop drawings, identifying cable type, manufacturer, and part number on the riser diagram. Include following information for each cable type with submittals.

    a) Shielded (overall shield)

    b) Stranded and insulated conductors

    c) Size conductors per manufacturer recommendations and power/voltage drop based on installed cable length.

    d) NFPA 70 jacket rating

2.03 TELECOMMUNICATIONS CABLING

A. Refer to Division 27 Specifications for telecommunications cabling requirements such as category cabling and optical fiber cabling.

2.04 CABLE IDENTIFICATION LABELS

A. Basis of Design: Brady BMP41

B. Available Manufacturers

1. Brady
2. Hellermann Tyton
3. Panduit

C. Description

1. Color Printing Capability: Single Color
2. Print Resolution: minimum 300 dpi
3. Print Technology: Thermal Transfer
4. Maximum Labels per Day: 25
5. Maximum Label/Tape Width: 1 inch
6. Device Connectivity: PC connected & Stand-alone

PART 3 - EXECUTION

3.01 CABLE INSTALLATION

A. Pre-Installation

1. Following the Notice to Proceed, the ESC's Quality Control Specialist or Project Manager (as defined in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS) shall coordinate with the Contractor or Sub-Contractor responsible for Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY (ie the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:
   a) Conduit routing
   b) Conduit type to building entrance(s)
2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:
   a) Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY
   b) Section 28 1000 - ELECTRONIC SECURITY SYSTEMS
3. After conduits/pathways are installed, but prior to cable installation, ESC's Quality Control Specialist and Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:

a) Conduit sizes and quantities matches Construction Documents and Project requirements

b) Minimum bend radius

c) Quantity of bends in conduit between pull boxes (180 degree change in direction, maximum)

d) Building entrance conduits are of appropriate type.

e) Any visible indication of improper or incomplete installation that may damage cable as it is installed.

B. General Requirements

1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.

a) Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 inches to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the equipment room, cables may be consolidated and routed in overhead conduit and conduit sleeves.

b) Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.

c) Conductors and cables as specified in this section shall be supported and installed into pathways, backboxes, firestopping, and other general/common work per Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY.

2. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor in backbox at each device location.

3. A Qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.

4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

a) Except when supported by ladder racking within each Telecommunications room, UON.

5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable

7. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.

8. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be a minimum of 3 feet in length, unless noted otherwise.

9. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.

10. Install cables and conductors in compliance with the requirements of Article 725 of the NFPA 70, paying special attention to the following:

    a) Cables shall be installed in a neat and workmanlike manner. Comply with NECA 1.

    b) Separation requirements dependent upon installation location and proximity to other circuits.

11. Work shall meet Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS and Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY.

C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Damp or Wet Locations or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab).

1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.

2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Equipment Room in accordance with the NFPA 70; or a suitably-sized junction box shall be provided in an accessible location within 50 feet of where the outdoor cabling/conduit enters the building enters the building to allow the cable to transition from wet-rated to plenum-rated.

a) Indicate this location on pre-construction shop drawings and final Record Drawings.

3. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

3.02 CABLE TERMINATIONS

A. Cable connections to device and security panel shall be soldered and heat-shrunk from jacket to jacket. Exposed conductors, even within an enclosure or back box, are not allowed.

3.03 CABLE TESTING

A. Pre-installation testing:

1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

2. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

B. Post-installation testing (but prior to termination to devices/panels):

1. Conduct cable continuity testing upon completion of installation on each conductor.

2. Remove all defective cables from pathway systems. Do not abandon cables in place.

3.04 CABLE IDENTIFICATION

A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings or as described in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS. Where the drawings and specifications are silent, submit RFI through appropriate channels requesting labeling scheme.

1. Shop drawings shall include floor plan and/or riser diagram that indicates proposed cable/device identification for each device.

B. Cables shall be labeled within 6 inches at each end.

3.05 ACCEPTANCE

A. The ESC's Quality Control Specialist shall conduct an inspection after conductors and cabling have been installed to ensure compliance with the Construction Documents and project requirements.

B. Functional tests of the conductors and cables connected to equipment will be conducted by the ESC as part of Test Reports as specified in Section 28 1000 -

ELECTRONIC SECURITY SYSTEMS and individual Electronic Security sub-system Sections.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Copper patch cables

1. Copper patch cables
2. Copper station cables

1.02 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

C. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

D. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

E. Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY

F. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

G. Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

H. Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

1.03 DEFINITIONS

A. Advanced System Warranty – warranty covering material and performance of the Structured Cabling System (SCS) offered by a reputable manufacturer. Refer to the Warranty paragraph of this specification for more information.

B. Certified Structured Cabling Contractor – a Contractor that is certified by one of the approved Structured Cabling manufacturers to install the Structured Cabling required for Electronic Security Systems and covered by that manufacturer’s Advanced System Warranty.

C. Communications Room – for the purpose of this section, means the location of a floor-serving facility for housing telecommunication equipment, cable

terminations, and cross-connect wiring. This room is recognized in TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities. The room may be identified by other names, including Equipment Room, IDF, MDF, IT, Telecom/Telecommunications Room, LAN, Network Room, etc. The functional connection points may also be in electronic security equipment rooms and/or racks; refer to drawings for exact locations and room names.

D. Damp Location – as defined by the NFPA 70, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.

E. Electronic Security Contractor (ESC) – The primary Contractor of this and all related specification sections (281000 through 283999). The ESC is also responsible for fully coordinating all Electronic Security System requirements with other Divisions and sections, such as power, grounding/bonding, fire alarm, and pathways/other common work.

F. Horizontal Cabling

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the Work Area Outlet and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called permanent link, a term that is used in the testing protocols.

    a) Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the Work Area Outlet.

    b) Bridged taps and splices shall not be installed in the horizontal cabling.

    c) Splitters shall not be installed as part of the optical fiber cabling.

2. The maximum allowable horizontal cable length for Category copper cable is 295 feet, which includes total cable length (including vertical routing and slack). Horizontal cables longer than 295 feet shall be optical fiber with power conductors (hybrid cable) with a Power-over-Ethernet Extender transmitter/receiver on each end.

    a) Power-over-Ethernet Extenders are specified in Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY.

G. Structured Cabling – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed category copper and/or fiber optic cable terminated onto a patch panel or outlet.

H. Wet Location - as defined in the NFPA 70, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

I. Work Area Outlet (WAO) - the outlet or connector at the far end of Horizontal Cabling.

1.04 REFERENCE STANDARDS

A. BICSI 005 - Electronic Safety and Security (ESS) System Design and Implementation Best Practices; Current Edition.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 Edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement; 2015a (Reaffirmed 2022).

E. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; IEC 61280-4.1 Edition 3.1, Fiber Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement; 2023d.

F. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2024.

G. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

H. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

I. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.

1.05 SUBMITTALS

A. Follow the requirements for submittals in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

B. Pre-Bid Submittal - the following submittals are due before the questions deadline before Bid:

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. Pre-Construction Submittal

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:

a) Division of Labor – including Company name and contact information of Project Manager for the Contractor performing this Work.

b) Warranty Specimen

1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and their terms/conditions.

2) Certified Structured Cabling Contractor Certificate from manufacturer that will issue Advanced System Warranty.

c) Contractor and Personnel Qualifications and Certificates

d) Schedule

e) Typed Parts List

f) Cut Sheets

1) Product data on cabling and patch cables shall contain the following:

(a) Manufacturers name and logo

(b) Cable outside diameter

(c) Number of conductors/strands in each cable

(d) Gauge or strand thickness

(e) Minimum transmission performance rating

(f) Cable jacket material and rating

(g) Maximum pulling tension

(h) Jacket/Sheath color

(i) Minimum bend radius

(j) During installation and post installation, if different

2) Product data on faceplates, modules, connectors, patch panels, and enclosures shall contain the following:

(a) Manufacturers name and logo

(b) Material type

(c) Performance rating

(d) Physical Dimensions

(e) Color

g) Shop Drawings

1) Scaled layout drawings showing the routing (and support method) of all cabling, and the locations where patch panels, Work Area outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), and fiber optic termination panels are to be installed.

2) Each individual Work Area Outlet on the drawings shall have proposed outlet identification indicated.

3) Scaled enlarged plan and rack elevation drawings showing the locations of patch panels and Rack-Mount Enclosures.

4) Unless otherwise required by these specifications, it is permissible to show Work in this section on Electronic Security shop drawings.

D. Preliminary Project Completion Submittal

1. As part of Section 28 1000 - ELECTRONIC SECURITY SYSTEMS – Preliminary Project Completion Submittal, include the following requirements:

a) Resubmit approved Pre-Construction Submittals of the following, updated to reflect all changes during construction:

1) Equipment List

2) Cut Sheets

3) Preliminary Record Drawings – based on drawings kept on site.

(a) Scans of on-site drawings are acceptable, provided notes and minor changes are legible.

(b) These drawings shall include the actual installed device and cable IDs that correspond to submitted test results.

b) Submit the following additional items:

1) Operation and Maintenance Manuals

2) Cable Test Results, in accordance with Part 3 of this section.

(a) Cable IDs shall correspond to submitted Preliminary Record Drawings.

E. Final Project Completion Submittal

1. As part of Section 28 1000 - ELECTRONIC SECURITY SYSTEMS – Final Project Completion Submittal, include the following requirements:

a) Updated Equipment List, Cut Sheets, Operation & Maintenance Manuals, and Test Results

b) Updated Record Drawings, in AutoCAD and searchable PDF file formats

c) Advanced System Warranty Information and Certificates, including contact number for any warranty claim.

1.06 QUALITY ASSURANCE

A. Contractor Qualifications

1. Certified Structured Cabling Contractor capable of offering Advanced Systems Warranty from one of the manufacturers listed in Warranty paragraph below.

2. Provide a list of projects (no less than 2) of similar size, scope, and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

B. Personnel Qualifications:

1. Provide and maintain a Project Manager who is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend scheduled project meetings and be responsible for submittals.

2. The person(s) conducting the testing for Structured Cabling shall be a current BICSI Certified Level II Commercial Installer or higher.

3. Any additional personnel physically installing part of the Structured Cabling covered by this Division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.

4. Requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.

5. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.

1.07 WARRANTY

A. See Division 01 - CLOSEOUT SUBMITTALS, for additional warranty requirements.

B. General: Provide 25-year standards-based performance warranty for connectivity hardware and cable for end-to-end structured cable solution. If the product fails to perform per TIA-568 (SET) or meet manufacturer's application assurance, the manufacturer shall provide materials and labor free of charge to the Owner to remediate the issue. Work shall be performed promptly upon written notice from Contract Administrator or Owner. Warranty shall be administered by the manufacturer. Warranty program shall be flexible, allowing eligible moves, adds, and changes to be submitted for registration either at the time of completion or at later , when changes have accumulated. At project completion submittal, deliver warranties, in writing and properly executed, with the following information:

1. Warranty Certificate
    a) Term Commencement Date
    b) Term
    c) Who is covered?
    d) What is covered?
2. Application Assurance: Applications covered (future and present)
3. Disclaimers, limitations, and exclusions

C. Copper Cable System: List of acceptable connectivity and cable manufacturers are below. Copper Cable System warranty shall be guaranteed by a manufacturer below:

1. Belden Incorporated
2. CommScope Holding Company Incorporated
3. Proterial, Ltd.; Proterial Cable America, Inc
    a) With following connectivity partners: Siemon, Ortronics, Panduit, Leviton, CommScope, Hubbell, OCC, and Belden
4. Hubbell Incorporated
5. Legrand SA, Ortronics
6. Leviton Manufacturing Company, Incorporated
7. Nexans SA, Berk-Tek
    a) With following connectivity partners: Belden, CommScope, Hubbell, Ortronics, Panduit, and Siemon
8. Panduit Corporation
9. Prysmian SpA; General Cable
    a) With following connectivity partners: Panduit

10. The Siemon Company
11. LS Corporation; Superior Essex
    a) With following connectivity partners: Ortronics
12. Substitution: See Division 01 - PRODUCT REQUIREMENTS

1.08 COORDINATION

A. Review pathways and other Work, as installed per Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY, prior to performing any Work under this section for conformance to all referenced codes, standards, and guidelines.

1. While Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY is being installed, the Project Manager of this section and the ESC's Quality Control Specialist shall make weekly inspections and report any issues to the Prime Contractor for correction prior to installation of any cabling.
    a) Example – Conduit for data outlets shall not contain more than two 90-degree bends between pull points.

B. Coordinate with ESC for all Work in Communications / Equipment Rooms.

PART 2 - PRODUCTS AND MATERIALS

2.01 COPPER TWISTED PAIR CABLE

2.02 COPPER PATCH CABLES

A. General

1. Supply necessary patch cables and cross-connect wires to support electronic security systems.
2. The manufacturer of patch cables shall be the same as the copper twisted pair connectivity, unless otherwise specified.
3. Patch cables shall be factory-terminated and tested.

B. Copper Patch Cords

1. Basis of Design: ____
2. Acceptable Manufacturers
    a) See Warranty paragraph in Part 1.
3. Description
    a) Category performance shall be the same as copper patch panels.
    b) Cable shall be 4-pair, twisted pair with factory-terminated RJ-45 modules on each end.

c) Small diameter: less than 0.2 inch for smaller bend radius.

4. Quantity and Color

a) Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:

1) Total quantity shall be 100% of the terminated ports, in the following colors and lengths:

(a) Size length of patch cords to route between patch panel, through cable management, to associated network switch. Color shall be blue.

C. Copper Station Cables

1. Basis of Design: ____

2. Acceptable Manufacturers

a) See Warranty paragraph in Part 1.

3. Description

a) Same specification as Copper Patch Cords.

b) Cable shall be 4-pair, twisted pair with factory-terminated RJ-45 modules on each end.

c) Plenum: Use listed NFPA 70 Type CMP plenum cable.

PART 3 - EXECUTION

3.01 CABLE INSTALLATION

A. Pre-Installation

1. Following the Notice to Proceed, the Project Manager of the Work associated with this section shall coordinate with the ESC and the Contractor or Sub-Contractor responsible for Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY (i.e. the conduits, backboxes, etc.), if Contractor are different. Items of coordination shall include, but are not limited to:

a) Conduit routing

b) Conduit type for Building Entrance(s) – (see requirements below)

2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:

a) Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

b) Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

c) Section 28 1015 - TELECOMMUNICATIONS REQUIREMENTS FOR ELECTRONIC SECURITY

3. After conduits/pathways are installed, but prior to cable installation, the Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:

    a) Conduit sizes and quantities matches Construction Documents and Project requirements.

    b) Minimum bend radius

    c) Quantity of bends in conduit between pull boxes (180-degree change in direction, maximum)

    d) Building Entrance conduits are of appropriate type.

    e) Any visible indication of improper or incomplete installation that may damage cable as it is installed.

B. General Requirements

1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.

    a) Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 inches to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the Equipment Room, cables may be consolidated and routed in overhead conduit and conduit sleeves.

    b) Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pull boxes in accordance with Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.

2. Follow sustainability requirements in Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS.

3. Follow seismic requirements in Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY.

4. Install continuous conductors between outlets, devices and boxes without splices or taps, unless otherwise noted. Do not pull connections into raceways. Leave at least 12 inches of slack in backbox at each device location.

5. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, hook and loop straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

a) Except when supported by ladder racking within each telecommunications room, UON.

6. At the same time Horizontal Cabling are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

7. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

8. Comply with all referenced standards and guidelines.

9. Cables shall be masked, covered, or otherwise protected from being painted or encountering any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.

10. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:

    a) A minimum of 15 feet in length at camera locations.

    b) A minimum of 10 feet in length in the ladder rack of the serving Communications Room.

11. Use of any cable pulling lubricants is prohibited.

    a) Where lubricant is deemed necessary by the Contractor to facilitate installation of cable in conduit, submit RFI with explanation, effected conduit run, proposed lubricant type, letter from cable manufacturer indicating proposed lubricant will not damage or degrade cable, and a letter from the manufacturer providing the Advanced System Warranty that the use of this lubricant will not exclude that cable run from the required warranty.

12. Install all cables and conductors in compliance with the requirements of Article 725 of the NFPA 70, paying special attention to the following:

    a) Cables shall be installed in a neat and workmanlike manner. Comply with NECA 1.

    b) Separation requirements dependent upon installation location and proximity to other cables and sources of EMI.

C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Damp or Wet Locations or as required by these construction documents. (i.e., all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)

1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space, nor shall they be allowed to transition between different levels of the building.

2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Communications Room in accordance with the NFPA 70; or a suitably sized junction box shall be provided in an accessible location within 50 feet of where the outdoor cabling/conduit enters the building enters the building to allow the cable to transition from wet-rated to plenum-rated.

    a) Indicate this location on pre-construction shop drawings and final Record Drawings.

3. All cables which extend beyond the envelope/footprint of the building and serving devices mounted on the roof (or within 10 feet of the roof) shall be installed with entrance protectors in accordance with Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY.

D. Cables serving Elevators:

1. Provide cabling to the Elevator Demarcation Panel from the serving Communications Room.

2. For cameras located inside Elevator cabs, coordinate cable/conductor requirements with Elevator manufacturer/supplier/installer so that correct Elevator Traveling Cable(s) are installed. Additional adapters on each end of the Elevator Traveling Cable may be required to ensure camera signal distribution; include costs of such adapters in the Bid.

3.02 CONNECTOR INSTALLATION

A. Furnish and install all cable connectors as shown on the Drawings.

B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.

C. Copper UTP Connector Installation

1. Terminate all four pairs of each cable on one outlet jack.

2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.

3. The provision and termination of connectors for each cable shall be done as follows:

4. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer’s printed instructions.

5. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

D. Fiber Optic Connector Installation

1. In the Communications Room, all fiber optic cable strands shall be fusion-spliced to factory-terminated pigtailed adapters.

2. At device end, terminate/splice all fiber optic cable strands as shown on the Drawings.

3. All fiber optic connectors shall be installed with dust caps/covers.

3.03 FACEPLATE INSTALLATION

A. Furnish and install all faceplates in locations as shown on the Drawings. Provide label on front of faceplate with Cable Identification numbers.

3.04 BONDING AND GROUNDING

A. Comply with TIA-607.

3.05 CABLE IDENTIFICATION

A. Comply with TIA-606.

B. Follow cable identification requirements in Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY.

3.06 GENERAL CABLE TESTING

A. Pre-installation testing:

1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

2. Mark reels or boxes as tested/inspected.

3. Do not install any cable with less than the manufacturer’s guaranteed number of serviceable conductors.

4. The field-test instruments shall be within the calibration period recommended by the manufacturer and shall contain the most recent software and firmware provided by the manufacturer prior to testing.

B. Post-installation testing:

1. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.

2. Provide testing in accordance with manufacturer’s requirements for a fully warrantied cabling system(s) as required by these Contract Documents.

3. All outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.

4. Invite the Owner and Design Consultant to witness, review, or both witness and review field-testing.

    a) The Owner and the Design Consultant shall be notified of the testing start date (2) weeks before testing commences.

5. Remove all defective cables from pathway systems.

6. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found. Do not abandon cables in place.

C. All test results and corrective procedures are to be documented and submitted to the Design Consultant as part of the Project Completion submittal(s) of Section 28 1000 - ELECTRONIC SECURITY SYSTEMS a minimum of 1 week prior to the Final Acceptance Test.

1. Submit updated Record Drawings along with completed Test Results. Record Drawings shall have final outlet labels that correspond to the identification used in the Test Results.

2. Format of test results shall be:

    a) Electronic Database Test Results - Abbreviated results, in PDF and Excel/CVS file formats, shown in numerical / alphabetical order in a spreadsheet which depicts the following:

        1) Project Name

        2) Date of Preparation

        3) ID of Work Area Outlet / connector being tested.

        4) Date of test

        5) Contractor’s Name

        6) Media Type

        7) Make, Model and Serial Number of test equipment used.

        8) Date of Last Calibration

        9) Names of Test Crew

        10) Serving Communications Room Number

            (a) All tests shall be submitted in numerical / alphabetical order by Communications Room.

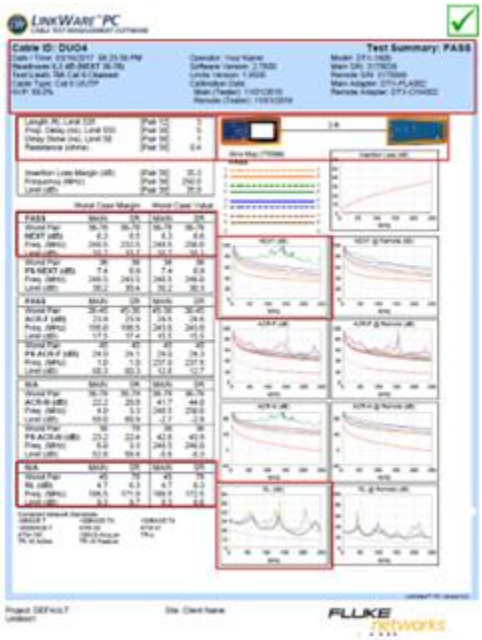
        11) Category of cable being tested.

        12) Abbreviated Test Results depicting Pass, Fail status.

    b) Full Test Results, native format – test results (in accordance with the Copper Cable Testing and Optical Fiber Testing paragraphs

below) saved within the field-test instrument and then transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of the test records, shown in numerical / alphabetical order in the file format of the tester (example: .mdb file), and unaltered.

c) Full Test Results, PDF format – full-page PDFs of each circuit tested, both for copper and fiber, similar to the following:



3.07 COPPER CABLE TESTING

A. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.

B. Copper Twisted Pair Cables:

1. After terminating both ends of cables, but before any cross-connects are installed, test these cables for the following:

a) Wire map

b) Length

c) Insertion loss

d) Near-end crosstalk (NEXT) loss.

e) Power sum near-end crosstalk (PSNEXT)

f) Equal-level far-end crosstalk (ELFEXT)

g) Power sum equal-level far-end crosstalk (PSELFEXT)

h) Return loss

i) Propagation delay

j) Delay skew

3.08 OPTICAL FIBER CABLE INSTALLATION

A. General:

1. Place all optical fiber cabling in accordance with these specifications, and as indicated on the Drawings.

2. Splices between optical fiber cables are permitted only at those locations indicated on the Drawings.

3. Comply with all referenced standards and guidelines.

B. Pre-installation testing:

1. Optical fiber cables: Perform visible light continuity check on each fiber. If one end is not accessible: perform OTDR test to assure fiber continuity.

3.09 OPTICAL FIBER CABLE TESTING

A. Post-installation Optical Loss testing:

1. After installation of connectors, visually inspect each fiber end-face at 50X magnification. Refinish fibers with visible defects and/or striations in the core area.

2. Perform end-to-end, bi-directional attenuation (loss) test for each fiber strand at 850nm and 1300nm. Conduct tests in accordance with TIA-526-14 , Method B and with test instrument manufacturer's printed instructions.

3. Perform end-to-end, bi-directional attenuation (loss) test for each fiber strand at 1310 and 1550 (single mode) wavelengths. Conduct tests in accordance with TIA-526-7, Method A.1 and with test instrument manufacturer's printed instructions.

4. Demonstrate that measured link loss does not exceed the "worst case" allowable attenuation loss. Calculate worst case allowable attenuation loss by:

a) Utilizing the following formulas as specified in TIA-568 (SET):

1) Link Attenuation (dB) = Cable_Attn (dB) + Connector_Attn (dB) + Splice_Attn (dB)

2) Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)

3) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)

4) Maximum allowable connector_loss = 0.75 dB

5) Splice_Attn (dB) = number_of_splices * splice_loss (dB)

6) Maximum allowable splice_loss = 0.3 dB

7) The values for the Attenuation Coefficient (dB/km) are listed in the table below:

TABLE 1: Fiber Optic Cable Attenuation Coefficient Values

TYPE OF OPTICAL FIBER	Wavelength (nm)	Attenuation Coefficient (dB/km)	Wavelength (nm)	Attenuation Coeffient (dB/km)
Multimode 62.5/125	850	3.5	1300	1.5
Multimode 50/125	850	3.5	1300	1.5
Singlemode (inside plant)	1310	1.0	1550	1.0
Singlemode (outside plant)	1310	0.5	1550	0.5

5. Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, the OTDR shall be used to: determine the true loss for each connector pair, the exact length of the fiber and to identify the presence of any core damage.

6. Faults related to fiber being connectorized shall be corrected, and the fiber re-tested as described above, until acceptable attenuation measurements are recorded.

7. Where defects are found to be inherent in the fiber itself: replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.

8. Dust caps shall be placed on fiber end faces or adapters for each optical fiber link after all testing is complete on the fiber link.

B. Testing jumpers used shall remain connected at the test equipment for the entire duration of testing. If at any time the jumper becomes loose or removed, for any reason, the jumper shall be reinstalled and re-referenced. This procedure shall be documented each time it is performed to indicate date, time and who performed the procedure. This log shall accompany test reports submitted.

C. All test results and corrective procedures are to be documented and submitted to the Owner and Design Consultant a minimum of 1 week prior to the Final Acceptance Review (as specified in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

3.10 ACCEPTANCE

A. All Work in this section is subject to the Project Completion and Schedule requirements of Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

B. After Final Acceptance Review:

1. Complete all Punch List items.

2. Retest effected cables.

3. Among other requirements, submit updated and complete Record Drawings/Test Results and the Advanced System Warranty certificate as part of Section 28 1000 - ELECTRONIC SECURITY SYSTEMS – Project Completion Final Submittal.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. Entrance Protection

B. Racks, Cabinets,and Enclosures

1. Floor Mounted Cabinet
2. Cabinet Accessories
3. Remote Equipment Cabinet Light Pole

C. Cable Management

D. Rack-mounted Power Protection and Power Strips

1. Horizontal Power Strip
2. Vertical Power Strip
3. Power Distribution Unit (PDU)
4. Uninterruptible Power Supply (UPS)

E. This Section does not include wall-mounted Electronic Security panels or rack-mounted Electronic Security network equipment such as switches or servers. Refer to other Division 28 Sections for those sub-system requirements.

1.02 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

C. Section 27 1000 - STRUCTURED CABLING

D. Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

E. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

F. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

G. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

H. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

1.03 DEFINITIONS

A. Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19 inches or 23 inches.

B. DVR – digital video recorder

C. Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 “Optical Fiber Cables and Raceways” and Article 800 “Communications Circuits” of NFPA 70.

D. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

E. NVR – network video recorder

F. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location in an Equipment Room and bonded by means of the bonding conductor to the building service equipment (power) ground.

G. POE – Power-over-Ethernet

H. Rack – A floor or wall mount unit without side panels. Racks can be constructed with 2 or 4 vertical posts. Rack-mounted equipment is supported by mounting rails separated at 19 inches or 23 inches.

I. RU – Rack Unit (1.75 inches high)

J. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location in an Equipment Room and bonded by means of the bonding conductor to the building service equipment (power) ground.

1.04 REFERENCE STANDARDS

A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.

B. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Electronic Equipment; 2005.

C. NECA/BICSI 607 - Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings; 2011.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2024.

F. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

G. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.

H. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

I. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current Edition, Including All Revisions.

J. UL 1363 - Standard for Relocatable Power Taps; current edition.

K. UL 1778 - Uninterruptible Power Systems; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Follow requirements in Division 01 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Pre-Bid Submittal

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. Pre-Construction Submittal

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:

a) Product Submittals (as part of complete Section 28 1000 - ELECTRONIC SECURITY SYSTEMS Pre-Construction Submittal):

b) Shop Drawings (as part of complete Section 28 1000 - ELECTRONIC SECURITY SYSTEMS Pre-Construction Submittal):

1) Enlarged Plans for each Equipment Room, at no smaller than 1/4 inch = 1 foot scale, showing 3 feet of clearance in front of all wall-mounted equipment and 3 feet of clearance

in front of and behind each floor-mounted equipment racks and cabinets.

2) Equipment rack and cabinet elevations, at no smaller than 1/2 inch = 1 foot scale, identifying each piece of rack-mounted equipment by product name, manufacturer, and part number.

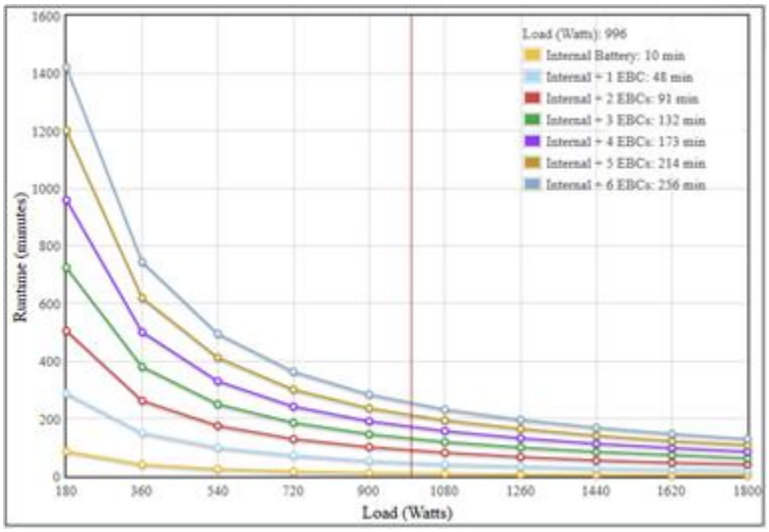
3) UPS Calculations

(a) On same sheet as equipment rack/cabinet elevation, include table showing power requirements (amperage) of each piece of rack-mounted equipment; at the bottom of the table, show total power requirements of all equipment. Show UPS battery calculations and runtime graph for the proposed UPS unit (and external batteries, if required) to meet the specified runtime requirements.

TABLE 1: Sample UPS Calculation

Equipment	Amps
Network Video Recorder	4.5
Owner's 48-port POE Switch	2.7
POE Extender Transmitters	1.1
Total Power Requirements	8.3

UPS runtime (Vertiv GXT4-2000RT120 with 1 external battery) @ 8.3A = 48 mins



D. Preliminary Project Completion Submittal

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:
    a) Test Results
        1) Include Test Report for all UPS units.

E. Final Project Completion Submittal
1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:
    a) Test Results
        1) Include Test Report for all UPS units.
    b) Record Drawings
        1) Grounding and Bonding
            (a) Add written confirmation that all required bonding connections have been made and the resistance tested to be 10 milli-ohms or below.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.

B. Equipment room fittings shall be listed by a NRTL.

PART 2 - PRODUCTS AND MATERIALS

2.01 ENTRANCE PROTECTION

A. Surge Protection
1. Basis of Design:
    a) Wall-mount Protectors: Vertiv Edco CAT6-POE
    b) Rack-mount Protectors: Vertiv Edco RM-CAT6-**POE
    c) Camera-end Protection: Vertiv CAT6-5POE-FF
2. Manufacturers
    a) APC
    b) Blackbox
    c) ITWLinx
    d) Substitution: See Division 01 - PRODUCT REQUIREMENTS
3. Description

a) Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NFPA 70 chapter 8. This includes:

1) Cameras mounted on the roof, parapet, or exterior wall within 10 feet of roof line.

2) Cameras mounted to site light poles or fences.

b) Comply with UL 497.

c) Shall meet TIA-568 (SET) performance standards.

d) Shall be capable of being used with POE+ applications.

e) Wall-mount Protectors

1) For single cables, where quantity of cables in Equipment Room needing protection is 6 or less.

f) Rack-mount Protectors

1) For more than 6 cables in an Equipment Room require surge protection.

2) Shall be rack-mountable in 19 inches wide equipment rack.

3) Provide quantity of Category protectors/modules required for install, plus 25% spare.

g) Camera-end Protection

1) For exterior POE cameras should have integral protection against power surges and transients. Where cameras do not have integral protection, provide the following at the far-end of cable connecting exterior POE camera:

(a) Blackbox Corp.; SPD512A CAT6 In-Line Surge Protector

(b) Vertiv Emerson Edco; CAT6-5POE-FF Surge Protection Device

2.02 RACKS, CABINETS, AND ENCLOSURES

A. Floor Mounted Cabinet

1. Basis of Design:

a) Chatsworth NF7L-113C-C42-1 (N-Series TeraFrame Gen 3) with the following:

1) Full-height PDU bracket

2) Fill any unused rack units with Snap-In Filler Panels

2. Manufacturers

a) Cooper B-Line

b) Great Lakes

c) Hoffman

d) Middle Atlantic

e) Substitution: See Division 01 - PRODUCT REQUIREMENTS

3. Description

a) Approximately 7 feet in height with at least 45RU available to mount panels/equipment.

b) Mounting rails shall be spaced 19 inches wide per EIA/ECA-310. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.

c) Finish shall be powder coated in black.

d) Minimum static load capacity: 1500 lb

e) Front-to-rear airflow.

f) Full front and back doors with perforated metal construction and key lock.

g) Side panels of solid metal construction.

h) Brush sealed cable entry on top.

i) All cabinet locks shall be keyed the same.

j) Secure cabinet to floor. Provide rack manufacturer's rack installation kit matching floor type of rack installation for a complete system meeting drawings and manufacturer instructions. Raised floor racks shall be mounted to sub or base floor with 5/8 inch threaded rods and steel brackets.

B. Cabinet Accessories

1. Temperature Sensor and Display

a) Based of Design:

1) For Middle Atlantic Cabinet: Middle Atlantic TEMP-DEC

2) For non-Middle Atlantic Cabinet: Middle Atlantic T1P with TEMP-DEC installed at top of the cabinet.

b) Description

1) Where active electronics are installed inside of a floor-mounted cabinet - such as network switches, DVRs/NVRs, or servers - provide temperature sensing of cabinet interiors.

2) Temperature display shall be visible external to the cabinet or in a 1RU panel located at the top of the front rack rails.

3) Temperature display shall connect to temperature sensor by a 5 feet cord. Install sensor away from drafts.

4) Connect dry switch closer/contact to Electronic Security alarm system and set sensor to trigger alarm at 95 degrees F. Coordinate final temperature alarm set point with Owner at time of Owner Training.

2. Tamper Switch

a) Basis of Design: GE Security / Sentrol 3010 series

b) Manufacturer shall be:

1) GE Security / Sentrol 3010 series

2) Substitution: See Division 01 - PRODUCT REQUIREMENTS

C. Remote Equipment Cabinet Light Pole

1. Basis of Design: Hoffman RE series

2. Description

a) as identified on drawings and/or for light pole locations as needed.

b) Minimum 16-gauge steel construction

c) Color shall be light grey.

d) Provide with lockable, hinged cover.

e) Size cabinet and provide all accessories needed for a complete installation, including but not limited to:

1) Patch Panel

2) Mounting brackets & rails

3) Fan w/dust filters

4) Back Board

5) Surge Suppression

6) Fiber Optic Brackets

2.03 CABLE MANAGEMENT

A. Where Electronic Security System equipment is co-located in a Communications Room, cable management shall be by Section 27 1000 - STRUCTURED CABLING Contractor, unless otherwise noted.

B. Where Electronic Security System equipment is in a Security Room only, cable management shall meet Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY.

2.04 RACK-MOUNTED POWER PROTECTION AND POWER STRIPS

A. Basis of Design: Refer to individual paragraphs.

B. Acceptable Manufacturers

1. Belden Incorporated
2. Chatsworth Products, Incorporated
3. CyberPower Systems (USA), Incorporated
4. Eaton Corporation PLC
5. Hammond Manufacturing
6. Hubbell Incorporated
7. Legrand SA; Middle Atlantic, Server Technology
8. Leviton Manufacturing Company, Incorporated
9. Lowell Manufacturing Company
10. nVent Electric PLC; Schroff
11. Panduit Corporation
12. Schneider Electric SE; APC
13. The Siemon Company
14. Tripp Lite
15. Vertiv Group Corporation; Geist
16. Substitution: See Division 01 - PRODUCT REQUIREMENTS

C. Horizontal Power Strip

1. Basis of Design: ____
2. Description
   a) UL Listed: UL 1363
   b) Operate at 120V AC / 60Hz.
   c) Minimum of 8 NEMA 5-15R receptacles.
   d) 1RU high and 19" wide per EIA/ECA-310.
   e) 15 A capacity with surge suppression on all outlets.

D. Vertical Power Strip

1. Description
   a) UL Listed: UL 1363
   b) Shall operate at 120 Vac / 60 Hz.
   c) Shall include a minimum of 10 NEMA 5-15R receptacles.

d) Shall have 20 A capacity with surge suppression on all outlets.

e) Provide one per equipment rack.

f) Cord Length: 10'-0"

E. Power Distribution Unit (PDU)

1. Description

a) UL Listed: UL 1363

b) Type: Monitored PDU

1) Metered

(a) Load meter LCD display on unit with amps.

2) Monitored

(a) Network interface for remote monitoring and reporting. Accessible via web browser and programmed to send alerts via e-mail.

(b) Remote environmental sensors: battery monitor

c) Input: NEMA 5-20P (20A, 120Vac, Single-Phase)

d) Output: Minimum of (8) NEMA 5-15P (15A,120Vac, Single-Phase)

e) Style: Vertical (7'-0")

f) Cord Length: 10'-0"

g) Mount Position: Side

F. Uninterruptible Power Supply (UPS)

1. Basis of Design: ____

2. Description

a) Type: Line Interactive UPS

b) Input: NEMA 5-15P (15A,120Vac, Single-Phase)

c) Output: Minimum of (8) NEMA 5-15P (15A,120Vac, Single-Phase)

d) Run Time: Minimum of 30 minutes

e) Style: Horizontal (2RU)

f) UL Listed: UL 1778

g) Monitored

1) Network interface for remote monitoring and reporting. Accessible via web browser and programmed to send alerts via e-mail.

2) Remote environmental sensors: battery monitor

h) Cord Length: 10'-0"

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to start-up of Electronic Security System, check all electrical circuits that will serve Electronic Security Equipment to ensure correct wiring polarity and ground impedance is less than 5.0 ohm (per IEEE 1100). Notify Design Consultant of any issues in a timely manner and await correction prior to use of effected circuits.

B. Labeling requirements

1. Equipment Racks, Cabinets, and Enclosures are to be labeled at the top of both the front and back sides, minimum text height shall be 3/8 inch.

a) Submit proposed labeling scheme on Shop Drawings for review and approval by Design Consultant and Owner.

1) For multiple racks/cabinets in a single equipment room, racks are to be numbered left to right, from front of room to back.

2) For projects with more than one Equipment Room, labeling scheme shall first indicate Equipment Room number/designator.

2. Wall-mounted Entrance Protectors shall be labeled with device/location it is protecting. Example – "Camera #54 on SW corner of building".

3. Grounding and Bonding conductors that leave the room shall be labeled with size, far-end destination, and total length. Example - #1/0 to Panelboard A2, 50 feet.

C. Quantities and sizes of equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.

D. Sustainable requirements shall meet Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS.

3.02 ENTRANCE PROTECTION

A. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NFPA 70 chapter 8.

B. Install grounding/bonding wire as straight as possible from protector to SBB/PBB.

C. Grounding and bonding

1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.

2. Bonding conductors shall be connected to the SBB/PBB as specified in this Section and in accordance with NFPA 70 chapter 8.

3.03 RACKS, CABINETS, AND ENCLOSURES

A. Wall cabinets and enclosures shall be installed on a plywood backboard or attached to a masonry wall. The rack should not be attached to sheet rock (gypsum wall board).

B. Tags/labels shall be placed on each equipment rack, cabinet, and frame in accordance with TIA-606.

3.04 CABLE MANAGEMENT

A. Horizontal and Vertical Cable Managers

1. Install cable organizers and/or cable channel on equipment racks and within cabinets at locations as described in the Specifications and/or indicated on the Drawings.

3.05 RACK-MOUNTED POWER EQUIPMENT

A. Uninterruptible Power Supplies (UPS)

1. Examination

a) Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

b) Proceed with installation only after unsatisfactory conditions have been corrected.

2. Installation

a) Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3. Grounding and Bonding

a) Ground/bond rack-mounted UPS equipment per manufacturer’s instructions.

4. Field Quality Control

a) Tests and Inspections:

1) Comply with manufacturer's written instructions.

2) Disconnect primary power source while connected equipment is in operation and document length of time until 10% battery life is left.

3) Test manual and automatic operational features and system protective and alarm functions.

4) Test communication of status and alarms to remote monitoring equipment / Owner's IT staff.

b) The UPS system will be considered defective if it does not pass tests and meets minimum runtime requirements.

c) Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

d) Prepare test and inspection reports.

5. Demonstration

a) Train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

3.06 GROUNDING/BONDING REQUIREMENTS

A. General:

1. Meet requirements of Section 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS and Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

2. Installation shall follow NECA/BICSI 607 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.

3. Install the grounding and bonding conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination.

4. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)

5. Size all grounding and bonding conductors per TIA-607.

6. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, the conductors shall be bonded to each end of the conduit using a grounding bushing and a No. 6 AWG conductor, minimum.

B. Required Connections:

1. Provide and install all bonding/grounding connections as required by Grounding Diagram Detail(s) on the drawings, and as required by equipment manufacturers, applicable codes, and the referenced standards.

2. Provide and install one individual ground wire from each equipment rack/cabinet/frame and wall-mounted enclosure to the SBB/PBB in the room. Each conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.

2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL 486A-486B.

D. Cable Identification:

1. Additional, provide a label above each SBB/PBB that states the following: IF CONNECTORS OR CABLES ARE LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING SECURITY MANAGER.

E. Quantities of Ground Wire / Bonding Conductors

1. Location and placement of grounding and bonding wires/conductors and components shall be as shown on the Drawings or defined herein.

2. Quantities of ground/bond wires/conductors, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a complete grounding and bonding system that meets the intent of these Specifications, the relevant codes, and referenced standards.

F. Testing

1. As a minimum test, as described below, all metallic bonding conductors installed under these Specifications.

2. Test the conductor and the terminal connectors for total resistance between the equipment item being grounded and the SBB/PBB in the room. This resistance shall be less than 0.10 Ohm (100 milliohms).

3. Recommended test equipment:

a) An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

b) Earth Ground Resistance Tester that is configured for continuity test (two-point test)

G. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. System Description

B. Owner Furnished Equipment

C. System Software

D. Head-end Equipment

1. Controllers
2. Entrance Protectors
3. Power Supplies & Integral Batteries
4. Wall-Mounted Enclosures

E. Devices

1. Card reader and Card reader/keypad
2. Credential cards
3. Mobile credentials
4. Request to Exit buttons - for remote door release
5. Push-button switches (Panic Buttons)
6. Interface with Door and Gate Hardware

F. Site Pedestal

G. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

H. Division 08 - DOOR HARDWARE

I. Division 08 - POWER DOOR OPERATORS

J. Division 11 - PARKING CONTROL EQUIPMENT

K. Division 11 - PEDESTRIAN CONTROL EQUIPMENT

L. Division 27 - COMMUNICATIONS

M. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

N. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

O. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

P. Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY

Q. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

R. Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

S. Section 28 1523 - INTERCOM ENTRY SYSTEMS

T. Section 28 3100 - INTRUSION DETECTION

1.02 ABBREVIATIONS AND DEFINITIONS

A. Access Control Cloud Services: Subscription-based hosted application utilizing Software as a Service (SaaS) delivery model in lieu of on-premises servers/software.

B. ACP: Access Control Panel

C. ACS: Access Control System

D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

E. Credential: Data assigned to an entity and used to identify that entity.

F. ESC: Electronic Security Contractor

G. Fail-Safe (Door): If power fails, the door is to be unlocked.

H. Fail-Secure (Door): If power fails, the door remains secure (locked).

I. I/O: Input/Output

J. LAN: Local Area Network

K. LED: Light-emitting Diode

L. PDF: Portable Document Format. The file format used by the Acrobat document exchange system software from Adobe.

M. RS-232: TIA-232 standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

N. RS-485: TIA-485 standard for multipoint communications.

O. WAN: Wide Area Network

1.03 REFERENCES

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

C. ISO/IEC 14443-4 - Cards and Security Devices for Personal Identification – Contactless Proximity Objects – Part 4: Transmission Protocol - Amendment 1: Dynamic Power Level Management; 2018, with Amendment (2021).

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

F. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 731 - Standard for the Installation of Premises Security Systems; current edition.

H. TIA-232 - Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange; 1997f (Reaffirmed 2012).

I. TIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems; 1998a (Reaffirmed 2012).

J. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

K. UL 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits; Current Edition, Including All Revisions.

L. UL 603 - Standard for Power Supplies for Use with Burglar-Alarm Systems; current edition.

M. UL 1076 - Proprietary Burglar Alarm Units and Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Follow the requirements for submittals in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

B. Pre-Bid Submittal - The following submittals are due before the questions deadline before Bid:

1. All products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary Code compliance and NRTL listing information.

C. Pre-Construction Submittal

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:

a) Product Cut Sheets and Shop Drawings shall be submitted concurrently as part of the complete Electronic Security Systems pre-construction submittal. If the first submittal only includes Product Cut Sheets, submittal will be returned with a "Not Reviewed" response.

b) Shop Drawings:

1) Submit plans, elevations, and details that include the following:

(a) Indicate all system device locations on architectural floor plans, identified by number/ID. No other system(s) shall be included on these plans.

(b) Enlarged Equipment Room wall elevation(s), indicating all wall-mounted pathways/cable management, wall-mounted enclosures, and all internal components of wall-mounted enclosures.

(1) All components on these elevations shall be identified by part name, manufacturer and model number.

(c) Include full schematic wiring information on these Drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device.

(d) Include a complete ACS one-line, block diagram.

(1) Each far-end device shall be identified by number/ID and room number.

(e) Include a statement of the system sequence of operation.

(f) Backup Power-Supply (Battery) Capacity Calculations

2) Graphical map screen shots within the access control software that will be used to depict building and device locations/status.

D. Preliminary Project Completion Submittal

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:

a) Test Results for the Access Control System. Refer to Project Close-Out Instruction in Part 3 of this Section.

E. Final Project Completion Submittal

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS submittal requirements, with additional requirements as noted:

a) Include scan of written documentation that Spare Parts/Physical Media were delivered to Owner at time of Owner training.

2. Refer to Project Close-Out Instruction in Part 3 of this Section and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for additional information and requirements.

1.05 QUALITY ASSURANCE

A. Contractor Qualifications

1. The ACS shall be provided by the Electronic Security Contractor (ESC), as defined in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

a) The ESC shall be a certified installed of the ACS vendor prior to bid; post-bid certification will not be accepted.

b) The ESC shall be pre-qualified; refer to Quality Assurance paragraph in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for a list of pre-qualified Contractor, and instructions for potential bidders wishing to become pre-qualified.

B. Personnel Qualifications

1. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for personnel qualifications.

1.06 WARRANTIES

A. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for warranty requirements.

1.07 COORDINATION

A. Access Control is an integrated system. Coordinate integration with installers and equipment of all other Electronic Security Systems.

B. Coordinate with elevator manufacturer and installer for integration of card readers for:

1. Call Button Control - For card reader(s) external to the elevator, adjacent to call buttons.

2. Floor Control - For card reader(s) internal to the elevator(s).

C. Within (2) weeks after the Notice to Proceed, schedule a meeting with the Owner's Security and/or Facility staff to confirm and coordinate additional sequence of operation and programming requirements of the ACS.

1. Document all direction from Owner in writing and distribute to the Design Consultant and Architect through the Prime Contractor.

PART 2 - PRODUCTS AND MATERIALS

2.01 SYSTEM DESCRIPTION

A. Provide a complete functioning Access Control System (ACS), and each element thereof, as specified, indicated, or reasonably inferred on the Drawings and in this Specification; including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to; materials, labor, supervision, supplies, tools, equipment, transportation, and utilities.

B. This Section consists of the control and monitoring of electro-mechanical barriers that limits physical access to authorized persons to openings (such as a gate or door) of a secured area (such as a property, facility, room, or cabinet). The system shall also monitor openings and initiate alarm if opening is forced open or left open for a set period of time.

C. The ACS shall be the platform for integration of all Electronic Security System sub-systems: thereby assuming the role of the Security Management System, as defined in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

D. Access Control Cloud Services

1. System shall consist of a cloud-hosted server provided by the Access Control as a Service (ACaaS) provider and new on-premise field-installed panels and devices. Coordinate connection to cloud serer with Owner's IT department, and provide gateway appliances as necessary.

2. Capacity: Unlimited cardholders; unlimited doors, readers, and administrators; unlimited workstations; unlimited events (viewable for 365 days).

3. Communication: Supports TLS 1.2+ authentication with AES-256 encryption.

4. Mobile Credentials: Supports Bluetooth Low Energy (BLE), Near Field Communication (NFC), and QR Code credentials.

a) Can function off-line and does not require a special application to be downloaded to the mobile device.

E. General Requirements

1. Unless otherwise designated, provide all of one type of equipment from one manufacturer.

2. Door Hardware Interface: Coordinate with Division 08 - DOOR HARDWARE that specify door and gate hardware required to be monitored or controlled by the ACS. The controllers in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 - DOOR HARDWARE to function with the software and hardware in this Section.

3. Tamper Protection: Provide tamper switches on control units/enclosures, power supply and battery cabinets, detection devices, pull/junction boxes, and equipment cabinets. These shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

4. Network connecting the Central Workstation/Server, other workstations/enrollment stations, and field-installed controllers/panels shall be via a dedicated VLAN on the Owner-provided network.

a) Additionally, the field-installed controllers/panels shall have a redundant network connection, via one of the following:

1) Dial-up modem connection using a standard dial-up (POTS) telephone line.

2) Cellular backup

2.02 OWNER FURNISHED EQUIPMENT

A. Certain technical system equipment shall be Owner furnished for use with the new technical system as indicated on the drawings and in these specifications. Provide any equipment not specifically noted as Owner Furnished Equipment (OFE).

B. Obtain this equipment from the Owner's Representative in a timely manner as required to coordinate with the project schedule. Verify all model numbers, quantities, sizes, and connector types as necessary to coordinate with system requirements. The Owner's Representative may elect to substitute other equipment in lieu of that listed prior to the submission of shop drawings.

C. Examine the equipment and perform normal operational checks to verify that the equipment is in good condition and is operating normally. Should any equipment defects be found (physical, electrical, or otherwise), identify, in writing to the Owner's Representative: a) defects found; and b) the estimated cost of any proposed repairs versus cost of replacement.

D. Where required for rack-mounting, furnish rack-mounting hardware or shelf for equipment not already having rack-mounting flanges. Also furnish security covers where such covers are required per the specifications.

E. Fully integrate the equipment with the technical system and provide all necessary signal connections and programming.

F. Proper operation and maintenance of such equipment remains the responsibility of the Owner's Representative.

G. Other Owner-furnished equipment may be used by the Owner's Representative with the new technical systems. Proper operation and maintenance of the equipment remains the responsibility of the Owner's Representative.

2.03 SYSTEM SOFTWARE

A. Owner's existing Access Control System (ACS) Software is Verkada .

2.04 HEAD-END EQUIPMENT

A. Controllers (Access Control Panels)

1. Access Control System hardware including intelligent controllers and modules (boards) for a complete and functional accesss control system.
2. Intelligent Controller shall:
    a) Store the credential holder database on-board.
    b) Support 10-BaseT/100Base-TX communication to the system Server/Central Workstation.
    c) Support 128-bit AES encryption, at a minium, between the system Server/Central Worksation and between the system modules.
    d) Support up to 16 card readers.
    e) Support OSDP readers.
3. Manufacturers
    a) Same manufacturer as the ACS.

B. Entrance Protectors

1. Basis of Design: DITEK Surge Protection
2. Manufacturer
    a) Same manufacturer as the ACS.
    b) Altronix
    c) LifeSafety Power
    d) Substitution: See Division 01 - PRODUCT REQUIREMENTS
3. Description

a) All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors. Card Readers/devices on the exterior face/wall of the building do not require protection.

b) UL Listing: UL 497B

c) Operating Temperature: -40°F to 158°F

C. Power Supplies & Integral Batteries

1. Manufacturer

a) Same manufacturer as the ACS.

b) Altronix

c) LifeSafety Power

d) Substitution: See Division 01 - PRODUCT REQUIREMENTS

2. Requirements:

a) Coordinate with Division 08 - DOOR HARDWARE that specify door hardware and gate hardware. Power supplies shall support power requirements of electrified latches, strikes, or magnets required.

b) UL Listings: UL 294, UL 603, and UL 1076

c) FCC: 47 CFR 15

d) Outputs shall be individually fused.

e) Automatic switch shall instantaneously transfer to stand-by battery power upon AC input failure without interruption, providing a minimum run-time of 30 minutes at full-load.

1) Power supply shall have integral charger for sealed lead acid or gel type batteries.

2) Low voltage battery cutoff shall prevent battery damage from excessive discharge.

3) Power supplies shall have supervisory relay outputs for AC or battery failure.

f) Fire alarm disconnect which enables emergency egress. The fire alarm disconnect shall be:

1) Capable of either latching or non-latching configuration.

2) Supervised; indicating fire alarm control panel input is triggered via output relay.

3) Individually selectable for any or all outputs.

g) LEDs shall indicate the presence of AC or DC voltage for input and each individual output. Dedicated LEDs shall indicate status of individually energized relays.

h) Power supply include network module capable of utilizing WAN/LAN to monitor status of AC input, output current, output voltage, temperature, and battery faults. Unit shall be user programmable via web browser with ability to send email fault and battery service notifications. User shall be able to pull reports/event logs.

D. Wall-Mounted Enclosures

1. Basis of Design: Verkada

2. Manufacturer

a) Same manufacturer as the ACS.

b) Altronix

c) LifeSafety Power

d) Substitution: See Division 01 - PRODUCT REQUIREMENTS

3. Description:

a) UL Listing: UL 294

b) NEMA EN 10250 enclosure(s) that protect against dust, falling dirt, fibers, lint, and dripping noncorrosive liquids:

1) Interior Electronics: NEMA EN 10250 Type 12

2) Exterior Electronics: NEMA EN 10250 Type 3R, stainless steel.

3) Corrosion Resistant: NEMA EN 10250 Type 4X, stainless steel.

4) Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.05 DEVICES

A. Card Reader and Card Reader/Keypad

1. Basis of Design: See type schedule on Electronic Security Legend

2. Manufacturers

a) See type schedule on Electronic Security Legend

3. Description

a) Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction and shall receive and decode a unique identification code number transmitted from the credential card.

1) Reader shall operate at 125 kHz and 13.56 MHz

b) Card readers shall also be Bluetooth Low Energy (BLE), Near Field Communication (NFC), and QR Codes compliant to enable the use of mobile phones as access credentials.

c) Card-Reader Power: Powered from its associated controller, including its standby power source.

d) UL Listing: UL 294

e) IEC 60529 rating (minimum): IP65

f) Transmission Protocol: ISO/IEC 14443-4

g) Status Indicators: Digital indicators shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

h) Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1) Indoors, controlled environment.

2) Indoors, uncontrolled environment.

3) Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

i) Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 msec. or less, from the time the card reader finishes reading the credential card until a response signal is generated.

B. Mobile Credentials:

1. Basis of Design: Verkada

2. Description

a) Digital credentials securely issued and stored on a Android or iOS mobile device.

b) Communication Protocols: Bluetooth Low Energy (BLE), Near Field Communication (NFC), and QR Codes

c) Security:

1) Minimum AES-128 encryption for credential storage.

2) Mutual authentication between device and reader.

C. Request-to-Exit Buttons - for remote door release

1. Basis of Design:

a) Momentary (MO) Push Button: Security Door Controls D15-2;

b) Momentary (MO) Push Button and Alternate Action (AA) Toggle Switch and Toggle: Security Door Controls D15-2-3

2. Description

a) Mounted under desk work surface.

b) Momentary and toggle SPDT push switch to release (unlock) an access-controlled door.

D. Push-button switches (Panic Buttons)

1. Wall-Mounted

a) Basis of Design: Schneider Electric XB4BS9445

b) Manufacturers

1) General Electric Company; GE Security, Inc.

2) Honeywell International Inc.; Honeywell Security.

3) Securitron

4) Visonic Ltd. (Johnson Controls)

5) Substitution: See Division 01 - PRODUCT REQUIREMENTS

c) Description

1) Switch shall lock in activated position until reset with a key.

2) Minimum Switch Rating: 50,000 operations.

3) Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2. Desk-Mounted

a) Basis of Design: Honeywell Security 269SN

b) Manufacturers

1) General Electric Company; GE Security, Inc.

2) Securitron

3) Schneider El

4) Visonic Ltd. (Johnson Controls)

5) Substitution: See Division 01 - PRODUCT REQUIREMENTS

c) Description

1) Switch shall lock in activated position until reset with a key.

2) Minimum Switch Rating: 50,000 operations.

3) Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

E. Interface with Door and Gate Hardware

1. Exit Alarm/Door Position Switch: All doors equipped with and electric/electromagnetic lock or strike shall also be equipped with a Door Position Switch. Operation of these doors shall generate an alarm under certain conditions - refer to other paragraphs in this Section for alarm requirements. Exit devices and alarm contacts are specified in Division 08 - DOOR HARDWARE. Coordinate division of labor and cabling with Division 08 - DOOR HARDWARE Contractor and Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY Contractor.

2. Door Position Switches: Use appropriately sized and placed end-of-line (EOL) resistors to provide circuit supervision of door position monitoring switch. Un-commanded door opening shall cause the system to generate and transmit a forced entry alarm. Coordinate division of labor and cabling with Division 08 - DOOR HARDWARE Contractor and Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY contractor.

2.06 SITE PEDESTAL

A. Manufacturers

1. Pedestal Pro
2. Chase Security Systems
3. Substitution: See Section 01 6000 - Product Requirements

B. Description

1. Custom pedestal rated for exterior use.
2. Shall meet dimensional and material requirements identified on architectural and security details.
3. Custom housing/hood is required to allow for all co-located devices to be within the same housing/hood, unless otherwise noted.
4. Submit dimensioned shop Drawing from manufacturer as part of pre-construction submittal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer's instructions.

B. Comply with NFPA 101.

C. See Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS for sustainability requirements.

D. See Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY for seismic controls.

3.02 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Obtain detailed project planning forms from ACS manufacturer; develop custom forms to suit project. Fill in all data available from project plans and specifications and publish as project planning documents for review and approval.

1. Record setup data for server and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.

15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Technical Drawings in electronic .dwg format.

B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up ACS software.

C. After turn-over of Equipment Rooms by the Prime Contractor and Division 26 (Electrical) Contractor:

1. Do not start up any powered ACS equipment until these requirements are verified.

a) Verify the Equipment Room is properly environmentally conditioned and all general construction dust and debris are removed.

b) Verify that all electrical branch circuits provided for the ACS equipment are installed properly and active.

2. Do not commence installation of any ACS equipment within Equipment Rooms until entry door to that room is equipped with a lock and construction key. All Equipment Room doors shall be locked, even during construction, when no personnel are present and working inside.

3.04 CABLING

A. Provide cabling for all access controlled doors and gates identified on the Drawings and these Specifications. Cable type and size shall meet all ACS vendor requirements for each type of device/connection. Coordinate the required cable Specifications with Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY Contractor (if different from the ESC) prior to Bid.

1. Utilize shielded cables/conductors, unless ACS vendor specifically forbids the use of shielded cables/conductors.

2. Use of a multi-conductor composite cable to access controlled doors is preferred, but not required, unless otherwise noted.

3. Coordinate cable size and pathway requirements with Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY Contractor.

B. Comply with NECA 1.

C. Cables and wiring shall be installed according to requirements in Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY.

D. Boxes and enclosures containing ACS components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes (J-boxes) and small device enclosures

below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and shall be secured with tamperproof screws.

E. Install appropriately sized and placed end-of-line (EOL) resistors at the field device location and not at the controller.

F. Ensure machine-printed, thermo-plastic labels are installed within 6 inches of each end of all cables.

G. Maintain insulation on all conductors to the final termination point within the enclosure; exposed copper conductors of any length are not allowed.

H. Provide a minimum of 6 inches of slack (service loop) at both ends of all cabling (at the device and within the ACS enclosure).

I. Obtain copper twisted pair patch cables from Section 27 1000 - STRUCTURED CABLING Contractor to connect ACS equipment to the Owner's network equipment. Coordinate Ethernet port assignments with Owner's IT staff. Provide and install patch cords at the IT rack and within the ACS enclosure(s).

3.05 CABLE APPLICATION

A. Coordinate these requirements with Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY.

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of ACS hardware.

C. TIA-232 (RS-232) Cabling (as required)

1. Install at a maximum distance of 50 feet.

D. TIA-485 (RS-458) Cabling (as required)

1. Install at a maximum distance of 4000 feet.

E. Card Readers and Keypads:

1. Install size and number of conductors or pairs as recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install #22 AWG wire if maximum distance from controller to the reader is 250 feet. Install #20 AWG wire if maximum distance is 500 feet.
3. For greater distances, install "extender" or "repeater" modules as recommended by manufacturer of the controller and devices.
4. Install minimum #18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum #16 AWG cable from controller to electrically powered locks. Adjust AWG in order to prevent voltage drop from power supply to the lock to drop below manufacture's stated minimum operating voltage.

G. Install minimum #14 AWG AC power wire from transformer to controller. Maximum distance of 25 feet.

3.06 BONDING AND GROUNDING

A. Properly bond and ground ACS equipment in accordance with:

1. Manufacturer's instructions
2. Per the Drawings
3. Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

B. Bond (to ground) cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Bond shields and drain conductors to ground at only one point (one end) in each circuit.

D. Each entrance protector shall have its own individual bonding/grounding conductor to the SBB. Do not bond entrance protectors to the ACS enclosure.

E. Each ACS enclosure shall have its own bonding/grounding conductor to the SBB. Do not daisy-chain enclosures together.

F. Minimum bonding/conductor size, in accordance with Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS , is #6 AWG.

3.07 IDENTIFICATION & LABELING

A. Coordinate with the Owner to develop an ACS identification plan. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

1. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
2. Enclosures shall be labeled with 2 inches by 4 inches engraved plastic label with 3/4 inch tall white characters. Attach label to enclosure door/cover with screws that do not extend more than 1/8 inch into the interior of the door/cover.

B. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet

to a building-mounted device shall be identified with the name and number of the particular device as shown.

C. At completion, Record Drawings and cable and equipment Excel spreadsheets shall reflect as-built conditions.

3.08 SYSTEM SOFTWARE

3.09 HEAD-END EQUIPMENT

A. Furnish, install, and configure (program) all required controllers, interfaces, and accessories in the rooms identified on the plans.

B. All head-end equipment shall be rack-mounted (where indicated) or shall be within wall-mounted enclosures. Refer to Drawings for mounting details.

C. Monitoring Requirements:

1. The ACS shall integrate with the Section 28 3100 - INTRUSION DETECTION. Event alarms from within the ACS shall communicate alarm type and location to the Intrusion Detection System.

2. The ACS shall monitor end devices and report an alarm for the following events:

a) Door Forced Alarm

b) Door Held Open Too Long

c) Panic/Duress Buttons

d) Invalid, Lost, Stolen, Expired, or Terminated Badge

D. Controllers (Access Control Panels) and Interfaces

1. Primary communication from the Access Control Panels to the Central Server/Workstation shall be over the Owner’s LAN/WAN.

a) The ACP shall maintain a current copy of the credential database.

b) In the event of a temporary LAN/WAN outage, the ACS shall continue to operate. When the LAN/WAN connection is restored, the ACS shall automatically upload events/logs to the Central Server and download a current copy of the credential database.

2. The ACS and ACPs shall be equipped with all required contact closures and interfaces to support the Monitoring Requirements paragraph above. Indicate these connections on Pre-Construction Shop Drawings and Record Drawings.

3. The ACS and ACPs shall be equipped with all required inputs and interfaces to support the Elevator Control requirements from Part 2 of this Section. Provide all materials and programming necessary that restricts access to the Elevator Cab and/or certain floors to authorized credential holders.

a) Coordinate with elevator installer for integration of in-cab card readers; the presentation of an authorized credential shall allow the elevator call button for approved/programmed floors to be enabled.

E. Wall-Mounted Enclosures

1. Install enclosures on plywood backboard, with bottom of enclosures parallel to floor. Bottom of bottom enclosure(s) shall be no lower than 30 inches above finished floor and top of top enclosure(s) shall be no higher than 74 inches above finished floor.

2. All enclosures, even within secured Equipment Rooms, shall be provided with locks. All locks shall be keyed the same. Turn over three keys to Owner at time of Owner training. Obtain written documentation from Owner at this time and include copy with the Final Project Close-out Submittal.

3. Ensure label is installed on front face of each enclosure in accordance with Identification & Labeling Section above.

4. Clearly identify/label the entry point/source of 120V power.

5. Ensure that any 120V wiring with the enclosure is installed in conduit; exposed 120v circuits are not allowed.

6. Layout of controllers and interfaces within enclosures shall be consistent from enclosure to enclosure and Equipment Room to Equipment Room. For renovation and expansion of an existing facility, match layout of existing ACS enclosures.

3.10 DEVICES

A. Electrified Door and Gate Hardware

1. Coordinate with the Owner to determine and establish schedules for interior and external doors with electric/electro-magnetic locks. Coordinate these doors and schedule with Owner during initial coordination meeting with Owner immediately following Notice to Proceed. Owner will provide schedule details for when to lock and unlock at certain day/time intervals; such that entry can be made through door without a valid credential during normal work hours.

2. In the event of a loss of power, doors shall Fail-Secure.

3. All egress doors shall allow individuals to freely exit the door without valid credential. Refer to Code Plans in the architectural set of Drawings for egress door locations. Notify the Architect and Design Consultant immediately for any egress doors where free exit (without valid credential) conflicts with Contract Documents.

B. Card readers and card reader/keypad

1. ADA actuator doors

a) Doors with ADA operators and managed by ACS shall be cabled, configured, and programmed to require valid credential before ADA push-button can actuate respective door opener.

3.11 SITE PEDESTALS

A. Coordinate site prep Work and Division of Labor with Prime Contractor prior to installation.

B. Ensure underground conduit pathways are free and clear of debris and that a pull wire was provided by the Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY Contractor.

3.12 FIELD QUALITY CONTROL

A. Refer to Part 3 of Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for general installation and project close-out instructions.

B. Perform the following functional tests and inspections - and correct any issues - before requesting Final Acceptance Review by Design Consultant:

1. Follow Test Methods as required by ACS vendor.
2. Also follow Test Methods as listed in NFPA 731, Table 10.4.3(a) and Table 10.4.3(b)
3. Test Reports:
    a) Use Sample Record of Completion Report from NFPA 731, Figure A.4.12.2.1(3)(a) as cover page of Access Control Test Reports.
    b) Use Sample Access Control Report from NFPA 731, Figure A.4.12.2.1(3)(c) to document testing of all ACS components.
    c) Scan to PDF and combine these reports, arranged logically by serving Equipment Room and Device type/ID. Include this PDF as part of Preliminary Project Completion Submittal.

C. After Final Acceptance Review by Design Consultant, address/correct any issues, and re-test effected devices and components of the ACS.

1. Update Test Reports and include complete Test Reports as part of Final Project Completion Submittal.

3.13 STARTUP SERVICE

A. Complete installation and startup checks according to approved procedures that were developed in “Preparation” Article and with manufacturer’s written instructions.

B. Enroll and prepare credentials for Owner’s operators, management, and security personnel.

3.14 OWNER TRAINING/DEMONSTRATION

A. Engage a factory-authorized service representative to Train Owner's security and facility/maintenance personnel to adjust, operate, and maintain security access system. Assume a minimum of two 4 hour training sessions are required.

B. A training schedule shall be developed and submitted by the Contractor and approved by the Owner a minimum of two weeks prior to the planned training.

C. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. System Description

B. Intercom Entry

1. Answering Stations
2. Video Stations

C. Cables

D. Accessories

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 27 - COMMUNICATIONS

C. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

D. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

E. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

F. Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY

G. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

H. Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

I. Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

J. Section 28 1300 - ACCESS CONTROL

K. Section 28 2000 - VIDEO SURVEILLANCE

1.03 ACRONYMS AND DEFINITIONS

A. AC: Alternating Current

B. Electronic Security Contractor (ESC): The primary Contractor of this and all related specification sections (281000 through 283999). The ESC is also responsible for fully coordinating all Electronic Security System requirements with other Divisions and sections, such as power, grounding/bonding, fire alarm, and pathways/other common work.

C. DC: Direct Current

D. I/O: Input/Output

E. IP: Internet Protocol

F. LED: Light Emitting Diode

G. RFID: Radio Frequency Identification

1.04 REFERENCES

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2024.

E. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

1.05 SUBMITTALS

A. Refer to requirements in Division 01 - ADMINISTRATIVE REQUIREMENTS, Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for submittal procedures.

B. Pre-construction Submittal

1. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

2. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams.

3. Evidence of qualifications for installer.

4. Specimen Warranty: Submit sample of manufacturer's warranty.

5. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

C. Project Completion Submittal

1. See Division 01 - CLOSEOUT SUBMITTALS, for closeout submittals.

2. Manufacturer's certification that products meet or exceed specified requirements.

3. Field quality control test reports.

4. Operation and Maintenance Data: Include detailed information on system operation, equipment setup, replacement parts, and recommended maintenance procedures and intervals.

5. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

6. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

1.06 QUALITY ASSURANCE

A. Contractor qualifications:

1. The ESC, or a qualified Intercom Entry System Contractor acting as a sub-contractor to the ESC, shall have a minimum three (3) continuous years in the business of installing and integrating Video Intercom Systems.

2. ESC or qualified sub-contractor shall be a certified installer by the video intercom equipment manufacturers whose products shall be incorporated into this project. Post-award certification will not be accepted.

3. ESC or qualified sub-contractor shall maintain certification by the manufacturers thru the duration of the warrantee period.

B. Personnel qualifications

1. All equipment/device installation and programming shall be conducted by factory-certified technicians of the components being installed.

C. Warranty

1. At a minimum, the manufacturer(s) equipment shall be covered by a 1-year parts and labor warranty covered by the ESC starting from Substantial Completion.

2. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for warranty and service call requirements.

a) All Warranty Work shall be completed by factory-certified technician(s) of the component(s) being address.

1.07 COORDINATION

A. Refer to Section 28 1300 - ACCESS CONTROL and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for integration requirements with the Security Management System.

B. Coordinate the placement of intercom stations with millwork, furniture, equipment, etc. installed under other sections or by others.

C. Coordinate the work with other installers to provide power for equipment at required locations.

D. Coordinate the work with other installers to provide communication lines required for outside call forwarding where applicable.

E. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

F. Preinstallation Meetings:

1. Conduct meeting with facility representative to review intercom station and equipment locations.

2. Conduct meeting with facility representative and other related equipment manufacturers to discuss intercom entry system interface requirements.

G. Sequencing:

1. Do not install intercom stations until final surface finishes and painting are complete.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Division 01 - CLOSEOUT SUBMITTALS, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 - PRODUCTS AND MATERIALS

2.01 SYSTEM DESCRIPTION

A. Provide a complete functioning Intercom Entry System, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Installed separately from conventional general-purpose internal communications systems, the system shall be used for the following purposes as scheduled, indicated or required:

1. Intercom Entry communication
2. Integration with the access control system to unlock electrified locks at doors with intercom stations. Intercom exchange shall provide a dry contact input to the Access control system for requests to release locks at openings where intercoms are installed.

C. The system shall be comprised of:

1. Answering station(s)
2. Intercom entry station(s)
3. And associated cabling and equipment

D. The Intercom Entry System shall be integrated within the Security Management System (as defined in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS).

1. In addition to this integration, install and program the Intercom Entry System software client onto the Access Control System's security office workstation. This software client shall provide the same functionality as an Answering Station.
2. Intercom Entry System shall request to unlock door/gate through the Access Control System described in Section 28 1300 - ACCESS CONTROL.
3. Store and monitor camera video with Video Management System in Section 28 2000 - VIDEO SURVEILLANCE.

E. System Capacity: Support quantities of each station type indicated on Drawings.

2.02 INTERCOM ENTRY

A. Answering Station

1. Basis of Design: See Intercom Type Schedule on Electronic Security Legend

2. Manufacturers

a) See Intercom Type Schedule on Electronic Security Legend

B. Video Stations

1. Basis of Design: See Intercom Type Schedule on Electronic Security Legend

2. Manufacturers

a) See Intercom Type Schedule on Electronic Security Legend

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive Intercom Entry System prior to install.

B. Notify Contract Administrator of conditions that would adversely affect installation or subsequent use.

C. Do not begin installation until unacceptable conditions are corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer instructions.

B. The work includes furnishing all labor, materials, tools, equipment and documentation required for a complete integrated intercom / security and communication system.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Comply with ADA Standards and NFPA 101.

E. See Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS for sustainability requirements.

F. See Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY for seismic requirements.

G. Install intercom stations level and plumb.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Install power supplies and other auxiliary components in equipment rooms unless otherwise indicated.

J. Pathways shall meet Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY.

K. Bonding and Grounding shall meet Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

L. Cable Installation

1. Follow Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY and Section 27 1000 - STRUCTURED CABLING.

2. Installation of telecommunications cabling shall meet TIA-568 (SET) and TIA-569.

3. Conceal cables unless specifically indicated to be exposed.

4. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

M. ADJUSTING

1. Adjust Intercom Entry System for proper operation in accordance with manufacturer’s instructions.

3.03 FIELD QUALITY CONTROL

A. See Division 01 - QUALITY REQUIREMENTS, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's field reports with submittals.

C. Test to verify wiring is free of shorts and grounds.

D. Prepare and start system in accordance with manufacturer's instructions.

E. Test system for proper operation.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. See Division 01 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL, for additional requirements.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 DEMONSTRATION AND TRAINING

A. See Division 01 - DEMONSTRATION AND TRAINING, for additional requirements.

B. Demonstration:

1. Demonstrate that integrated security and communication system functions properly.

2. Perform demonstration at final system inspection by qualified representative of manufacturer.

C. Instruction and Training:

1. Provide instruction and training of Owner's personnel as required for operation of Intercom Entry System.

2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.

3. Provide instruction and training by qualified representative of manufacturer.

3.06 PROTECTION

A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. System Description

B. System Component Requirements

C. Enclosures

D. Devices

1. Keypad and Display Module
2. Microwave-PIR Dual-Technology Sensors
3. Duress-Alarm Switches - Standard
4. Duress-Alarm Switches – Desk Mounted

E. Control Unit

F. Duress Alarm Strobe

G. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

H. Division 08 WINDOWS AND DOORS

I. Division 26 ELECTRICAL

J. Division 27 COMMUNICATIONS

K. Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

L. Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS

M. Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

N. Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY

O. Section 28 1000 - ELECTRONIC SECURITY SYSTEMS

P. Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

Q. Section 28 1020 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

R. Section 28 1300 - ACCESS CONTROL

S. Section 28 2000 - VIDEO SURVEILLANCE

1.02 ACRONYMS AND DEFINITIONS

A. PIR: Passive infrared

B. RFI: Radio-frequency interference

C. Control Unit: System component that monitors inputs and controls outputs through various circuits.

D. Primary Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

E. Monitoring Station: Facility that receives signals and has personnel always in attendance to respond to signals. A central station is a monitoring station that is listed.

F. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

G. Standard Intruder: A person who weighs at least 100 lb and whose height is at least 48 inches; dressed in a long-sleeved shirt, slacks, and shoes.

H. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

I. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

J. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to primary control unit.

K. ASTM A574 - Standard Specification for Alloy Steel Socket-Head Cap Screws; current edition.

L. ASTM F835 - Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws; current edition.

M. ASTM F837 - Standard Specification for Stainless Steel Socket Head Cap Screws; current edition.

N. ASTM F879 - Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws; current edition.

O. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

P. NFPA 731 - Standard for the Installation of Premises Security Systems; current edition.

Q. SIA CP-01 - Control Panel Standard; current edition.

R. SIA PIR-01 - Passive Infrared Motion Detector Standard; current edition.

S. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.

T. UL 603 - Standard for Power Supplies for Use with Burglar-Alarm Systems; current edition.

U. UL 609 - Local Burglar Alarm Units and Systems; Current Edition, Including All Revisions.

V. UL 634 - Connectors and Switches for Use with Burglar-Alarm Systems; Current Edition, Including All Revisions.

W. UL 639 - Intrusion-Detection Units; Current Edition, Including All Revisions.

X. UL 681 - Installation and Classification of Burglar and Holdup Alarm Systems; current edition.

Y. UL 1610 - Central-Station Burglar-Alarm Units; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Refer to requirements in Section 28 0010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS and Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

B. Include the following additional items as part of the Intrusion Detection submittals:

1. Bid

a) Unit Pricing: addition/deletion cost of an individual Motion Detector. Include all associated costs to furnish, install, terminate, test, and label, time, and fees to program the device into the

integrated Electronic Security System, and the required cabling and pathways to serve the device.

b) Alternate pricing to extend maintenance and support and product warranty as in the Quality Assurance section above.

1.04 QUALITY ASSURANCE

A. Contractor qualifications:

1. The ESC, or a qualified Intrusion Detection Contractor acting as a Sub-Contractor to the ESC, shall have a minimum five (5) continuous years in the business of installing and integrating Intrusion Detection Systems.

2. ESC or qualified Sub-Contractor shall be a certified installer by the intrusion detection equipment manufacturers whose products shall be incorporated into this project. Post-award certification will not be accepted.

3. ESC or qualified Sub-Contractor shall maintain certification by the manufacturers thru the duration of the warrantee period.

B. Personnel qualifications

1. All equipment/device installation and programming shall be conducted by factory-certified technicians of the components being installed.

C. Warranty

1. At a minimum, the manufacturer(s) equipment shall be covered by a 1-year parts and labor warranty covered by the ESC starting from Substantial Completion.

2. Refer to Section 28 1000 - ELECTRONIC SECURITY SYSTEMS for warranty and service call requirements.

a) All Warranty Work shall be completed by factory-certified technician(s) of the component(s) being address.

3. Include, as part of Base Bid, the associated cost to extend a parts and labor warranty for Intrusion Detection components from 1-year to 3 years.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide a complete functioning Intrusion Detection System, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation, and utilities.

B. The general scope includes, but is not limited to, these main systems:

1. Duress alarms, with communication links to perform monitoring, alarm, and control functions.

2. Systems Integration with the following systems and equipment:

a) Electronic door hardware via Access Control System.

b) Secondary reporting to Access Control System.

c) Video Surveillance System.

C. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

D. Review Construction Drawings for information related to the functional description of the system.

E. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at primary control unit and actuate audible and visual alarm devices.

2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.

3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

F. System Control: Primary control unit shall directly monitor intrusion detection units and connecting wiring.

G. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

H. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.

2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.

3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.

4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.

5. Protected Zone Test: Initiate operational test of a specific protected zone.

6. System Test: Initiate system-wide operational test.

I. Timed Control at Primary Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

J. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

1. Switch signal to selected monitor from video surveillance camera in vicinity of sensor signaling an alarm.

K. Report Generation: Pre-program the ability to easily generate a report (in spreadsheet file format) of the following - a record of alarm, supervisory, and trouble events. Entries shall include protected zone, device, and function.

L. Response Time: Two seconds between actuation of any alarm and its indication at primary control unit.

M. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from primary control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at primary control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

N. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

O. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.02 SYSTEM COMPONENT REQUIREMENTS

A. Compatibility: Detection devices and their communication features, connecting wiring, and primary control unit shall be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Division 08 - DOOR HARDWARE.

2. Access control system specified in Section 28 1300 - ACCESS CONTROL.

3. Video surveillance system specified in Section 28 2000 - VIDEO SURVEILLANCE.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements per Section 26 4313 - SURGE PROTECTIVE DEVICES.

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

E. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Primary control-unit alarm display shall identify tamper alarms and indicate locations.

F. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to primary control unit.

G. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to primary control unit as an alarm signal.

H. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to primary control unit.

I. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at primary control unit for calibration, sensitivity, and alarm condition.

2.03 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA EN 10250, Type 12.

C. Exterior Electronics: NEMA EN 10250, Type 4X, stainless steel.

D. Corrosion Resistant: NEMA EN 10250, Type 4X, stainless steel.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.04 DEVICES

A. Keypad and Display Module

1. Basis of Design: Bosch Security Systems, Inc.
2. Acceptable Manufacturers
   a) ____
   b) Substitution: See Division 01 - PRODUCT REQUIREMENTS
3. Description
   a) Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.
   b) Provide a Keypad compatible with the Intrusion Detection Control Panel.
   c) Shall have a minimum 5" color LCD touchsceen display.
   d) Shall have a built-in proximity reader as an option.
   e) Shall have be a.

B. Contacts (Door Position Switches):

1. Listed and labeled as complying with UL 634.
2. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors or windows.
   a) Use standard security contacts (not balanced magnetic type) unless otherwise indicated.
   b) Use high security contacts (balanced magnetic type) for _____.
      1) High Security Contacts: Balanced magnetic type; designed to activate upon attempts to defeat contact through external magnetic tampering.
3. Contacts shall be Double Pole, Double Throw (DPDT) and connect to both the Access Control and Intrusion Detection Systems.
4. Contact Color: To be selected by Architect from manufacturer's available standard colors.

5. Basis of Design Products:
    a) _____.

C. Microwave-PIR Dual-Technology Sensors
1. Basis of Design: Honeywell DT7435
2. Acceptable Manufacturers
    a) Bosch Security Systems, Inc.
    b) General Electric Company; GE Security, Inc.
    c) Visonic Inc.
    d) ____
    e) Substitution: See Division 01 - PRODUCT REQUIREMENTS
3. Description
    a) Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
    b) Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
    c) Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.

D. Duress-Alarm Switches - Standard
1. Basis of Design: Schneider Electric XB4 BS9445
2. Acceptable Manufacturers
    a) General Electric Company; GE Security, Inc.
    b) Honeywell International Inc.; Resideo Technologies, Inc.
    c) Visonic Inc.
    d) ____
    e) Substitution: See Division 01 - PRODUCT REQUIREMENTS
3. Description
    a) Switch shall lock in activated position until reset with a key.
    b) Minimum Switch Rating: 50,000 operations.
    c) Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

E. Duress-Alarm Switches – Desk Mounted
1. Basis of Design Product: Resideo Pro 269SN

2. Acceptable Manufacturers

a) General Electric Company; GE Security, Inc.

b) Schneider Electric

c) Visonic Inc.

d) ____

e) Substitution: See Division 01 - PRODUCT REQUIREMENTS

3. Description

a) Switch shall lock in activated position until reset with a key.

b) Minimum Switch Rating: 50,000 operations.

c) Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2.05 CONTROL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Bosch Security Systems, Inc.

2. ____

3. Substitution: See Division 01 - PRODUCT REQUIREMENTS

B. Description:

1. Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

a) System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

b) Include a real-time clock for time annotation of events on the event recorder and printer.

c) Addressable initiation devices that communicate device identity and status.

d) Control circuits for operation of mechanical equipment in response to an alarm.

2. Construction: Freestanding equipment cabinet, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.

3. Comply with UL 609, SIA CP-01, UL 603, and UL 1610.

4. Console Controls and Displays: Arranged for interface between human operator at primary control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

    a) Annunciator and Display: LCD, two lines of 40 characters, minimum.

    b) Keypad: Arranged to permit entry and execution of programming, display, and control commands.

    c) Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.

    d) Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.

    e) Coordinate operator commands.

    f) Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

        1) Acknowledge alarm.

        2) Silence alarm.

        3) System reset.

        4) LED test.

    g) Timing Unit: Solid state, programmable, 365 days.

    h) Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their respective on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.

    i) Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone originating the alarm appears on LCD display at primary control unit. Annunciator panel displays a common alarm light and sounds an audible tone. and Duress alarm activation sounds a siren and strobe as well as keypad annunciation.

5. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

6. Power Supply Circuits: Primary control units shall provide power for remote power-consuming devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

7. Verify that manufacturer can provide UPS to provide a minimum of six hours of primary control unit operation.

8. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.

9. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over client-provided Ethernet network (LAN).

2.06 DURESS-ALARM STROBE

A. Basis of Design: Federal Signal 141ST

B. Acceptable Manufacturers

1. General Electric Company; GE Security, Inc.

2. Honeywell International Inc.; Honeywell Security.

3. Visonic Inc.

4. _____

5. Substitution: See Division 01 - PRODUCT REQUIREMENTS

C. Description

1. Provide with a Red lens

2. Suitable for use with a 24VDC power supply.

3. Drive System Types: Pinned Torx.

4. Socket Flat Countersunk Head Fasteners:

a) Heat-treated alloy steel, ASTM F835.

b) Stainless steel, ASTM F879, Group 1 CW.

5. Socket Button Head Fasteners:

a) Heat-treated alloy steel, ASTM F835.

b) Stainless steel, ASTM F879, Group 1 CW.

6. Socket Head Cap Fasteners:

a) Heat-treated alloy steel, ASTM A574.

b) Stainless steel, ASTM F837, Group 1 CW.

PART 3 - EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer's instructions.

B. Meet sustainability requirements per Section 28 0013 - SUSTAINABLE DESIGN REQUIREMENTS.

3.02 INDENTIFICATION / LABELING

A. Label devices, switches, primary control unit(s), strobes, and associated cabling with identification number/room number as indicated on the drawings. Where drawings are silent, coordinate labeling scheme with Owner prior to pre-construction submittals and indicate proposed identification/labeling on pre-construction shop drawings.

B. Primary Control Unit enclosures shall be labeled as follows:

1. Cover shall be identified as “Electronic Security System – Intrusion Detection – Primary Control Unit (insert identifier)”

2. Cabling for devices shall be labeled at both ends with “(Device Type) – (insert identifier)”. Example: Motion Detector #12 (Corridor A101)

3.03 START-UP OF SYSTEMS

A. Prior to system start-up, conduct the following examinations:

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

2. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

4. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

a) Remove and replace anchors where inspections indicate that they do not comply with requirements. Re-inspect after repairs or replacements are made.

b) Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

5. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

6. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 28 0548 - SEISMIC CONTROLS FOR ELECTRONIC SECURITY.

C. Security Fasteners: Where accessible to standard intruder, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

D. Wiring Installation

1. Wiring Method: Install wiring in metal raceways according to Section 28 0510 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY. Control and data transmission wiring shall not share conduit with other building wiring systems.

2. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3. Wires and Cables:

a) Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.

b) 120-V Power Wiring: Shall be by Division 26 Contractor coordinate final connection.

c) Control and Signal Transmission Conductors: Install shielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends unshielded cable, according to Section 28 1010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY.

d) For Primary Control Unit connection to the Electronic Security Network, See Section 27 1000 - STRUCTURED CABLING for network cabling requirements.

e) Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

f) Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

g) Identify components with engraved, laminated-plastic or metal nameplate for primary control unit and each terminal cabinet, mounted with corrosion-resistant screws.

E. GROUNDING

1. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

2. Ground equipment in accordance with manufacturer requirements and TIA-607.

3. Refer to grounding requirements of Section 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

3.05 PROJECT CLOSE-OUT INSTRUCTIONS

A. Functional Testing

1. Conduct and finish functional tests of the Intrusion Detection system, and integrated testing where applicable.

2. Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

a) Inspection: Verify that units and controls are properly labeled, and interconnecting wires and terminals are identified.

b) Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

3. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation" and submit as part of Preliminary Project Completion

Submittal as required by Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

B. Follow all other Project Close-Out requirements as detailed in Section 28 1000 - ELECTRONIC SECURITY SYSTEMS.

3.06 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

END OF SECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 28 Section "Common Work Results for Electronic Safety and Security," for materials and methods for coordination, sleeves and common installation requirements.

1.02 DESCRIPTION OF WORK

A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.

B. Division 28 of the Specifications and Drawings numbered with prefixes FP generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. The scope of work in this section includes:

1. Fire alarm control unit
2. Remote annunciator
3. Manual fire alarm pull stations
4. System smoke detectors
5. Notification appliances
6. Sprinkler system waterflow and valve tamper alarms
7. Elevator recall
8. Air handling unit shutdown
9. Battery stand-by power
10. Multi-channel one-way voice notification system
11. Digital alarm communicator transmitter (DACT)

1.03 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.04 APPLICABLE CODES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be

reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.

1. NFPA (National Fire Protection Association) 70, "National Electrical Code", 2020 Edition.
2. NFPA 72, "National Fire Alarm and Signaling Code", 2019 Edition.
3. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
4. International Building Code (IBC) 2021 Edition with local amendments.
5. International Fire Code 2021 Edition with local amendments.
6. ICC/ANSI A117.1, "Accessible and Useable Buildings and Facilities", Current edition.
7. ASME A17.1, "Safety Code for Elevators and Escalators", Current Edition.

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.05 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

6. FACP: Fire Alarm Control Panel.

7. NICET: National Institute for Certification in Engineering Technologies.

8. VESDA: Very Early Smoke-Detection Apparatus.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.06 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.

C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.

F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:

1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.

2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.

3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.

4. Conduit shall be by Division 26 "Common Work Results for Electrical".

G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.07 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.08 SUBMITTALS

A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.

B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.

C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.

D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the

license agreement for transfer of information at the end of this section must be used.

E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.

F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve him from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.

J. Shop Drawings:

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

2. Shop drawings shall be prepared by a NICET Level 3 or higher certified technician. Submit copies of the certification for the designer with submittal.

3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.

4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).

5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.

6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.

7. Include voltage drop calculations for notification-appliance circuits.

8. Include battery-size calculations.

9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than 3/32" = 1'-0".

K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.

L. Qualification Data: Submit copies of the certification for the Installer.

M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.09 ELECTRONIC DRAWING FILES

A. In preparation of shop or record drawings, Contractor may, at his option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for Substitutions.

B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.

D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.

B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:

1. Typewritten Index.
2. Qualifications. Provide designer and installer qualification.
3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
5. Product Data: Provide product cutsheets for all equipment utilized and installed.
6. Riser diagram.
7. Device addresses.

8. Record copy of site-specific software.

9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

   a) Equipment tested.

   b) Frequency of testing of installed components.

   c) Frequency of inspection of installed components.

   d) Requirements and recommendations related to results of maintenance.

   e) Manufacturer's user training manuals.

10. Manufacturer's required maintenance related to system warranty requirements.

11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.

12. Guarantee. Copy of all guarantees and warranties issued.

13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.

B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.

C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.

D. Refer to Division 1 and General Conditions for Record Drawings

E. At the completion of the project, the Contractor shall obtain at his expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. These drawings shall be delivered to the Architect/Engineer.

1.13 SPARE PARTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide 10% of the total or a minimum of one (1) manual pull station.
2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
3. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.
4. Provide 5% of the total or a minimum of two (2) of each speaker type. Combination speaker/strobe units matching the units installed are acceptable.
5. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.

B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.

C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.

D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

A. Refer to Division 1 and General Conditions for Guarantees and Warranties.

B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.

C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.

D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.

E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

1.16 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.17 SEQUENCING AND SCHEDULING

A. Existing Fire alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire alarm system, remove all unused fire alarm equipment, wiring and installation materials not necessary for system functionality or spare parts.

PART 2 - PRODUCTS AND MATERIALS

2.01 SYSTEM DESCRIPTION

A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice/strobe evacuation.

B. All components provided shall be listed for use with the selected system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.02 MANUFACTURER

A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:

1. Notifier
2. SimplexGrinnell
3. Siemens-Cerberus Division
4. Kidde/Edwards
5. Gamewell-FCI

6. Fike

7. Silent Knight

2.03 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual pull stations.

2. Smoke detectors.

3. Air-sampling smoke-detection system.

4. Automatic sprinkler system water flow.

5. Fire extinguishing system operation.

B. Fire alarm signal shall initiate the following actions:

1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).

a) A pulsing alarm tone shall occur within the control panel until acknowledged.

b) The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.

2. Transmit an alarm signal to the alarm supervising station.

3. Audible notification appliances shall sound until silenced by the alarm silence switch at the control panel.

4. All visible alarm notification appliances shall display a continuous synchronized pattern until reset by the Alarm Reset Switch.

5. Record events in the system memory.

6. Activate voice/alarm communication system.

7. All air-handling systems that are monitored shall shutdown and remain down until the fire alarm control panel is reset.

8. Activate emergency lighting control.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

2. Duct-smoke detectors

3. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
4. Fire pump power phase reversal.
5. Independent fire detection and suppression systems.
6. User disabling of zones or individual devices.
7. Loss of communication with any panel on the network.

D. System Supervisory Signal Actions:
1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
    a) Visible and audible supervisory alarm indicated by address at fire alarm control panel.
    b) Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
2. Record events in the system memory.
3. Within 90 seconds transmit a supervisory signal to the alarm supervising station.
4. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.

E. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire alarm control unit.
5. Ground or a single break in internal circuits of fire alarm control unit.
6. Abnormal ac voltage at fire alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire alarm control unit or annunciator.
10. Voice signal amplifier failure.

F. System Trouble Signal Actions:

1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).
    a) Visible and audible trouble alarm indicated by address at fire alarm control panel.
    b) Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
2. Record events in the system memory.
3. After a time delay of <90 seconds>, transmit a trouble signal to the alarm supervising station.

2.04 FIRE ALARM SYSTEM CONTROL UNIT

A. General Requirements for Fire alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
    a) System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b) Include a real-time clock for time annotation of events on the event recorder and printer.
    c) Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d) The FACP shall be listed for connection to a central-station signaling system service.
    e) Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
    f) The control unit shall have dedicated alarm, supervisory and trouble LED’s and dedicated alarm, supervisory and trouble acknowledge, and alarm silence switches.
    g) Lamp Test: Manual lamp test function causes each LED to function at fire alarm control panel.
    h) Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.
    i) Install in a surface mounted enclosure.
    j) The fire alarm system control unit shall be UL listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.

1. Initiating Device Circuits: Class B.

a) Pathway Survivability: Level 0.

2. Notification Appliance Circuits: Class B.

a) Pathway Survivability: Level 0.

3. Signaling Line Circuits: Class B.

a) Pathway Survivability: Level 0.

D. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. The location of the dedicated branch circuit disconnecting means shall be permanently identified at the control unit.

2. The circuit disconnecting means shall have a red marking and be provided with a breaker lock or other approved method to avoid accidental operation.

3. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

E. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead acid.

2. The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 15> minutes.

F. System Supervision: Automatically detects and reports open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification appliance circuits. Alarm, supervisory and trouble signals shall be monitored by the supervising station over a Digital Alarm Communicator Transmitter (DACT), or other approved method.

G. Elevator Recall and Shutdown: Provide output signals to the elevator controller(s) using addressable relays to initiate elevator recall and shutdown functions per ASME A17.1. Provide equipment, output signals and logic as required by code and by the elevator system supplier and installer.

1. Elevator recall shall be initiated by any one of the following alarm-initiating devices:

a) Elevator lobby detector(s).

b) Smoke detector in elevator machine room.

c) Smoke detector(s) in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.

3. Elevator shutdown shall be initiated by any one of the following alarm-initiating devices:

a) Heat detector in elevator machine room.

b) Heat detector(s) in elevator hoistway.

2.05 EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEMS (EVACS):

A. The system shall incorporate one-way emergency voice communication via specified speakers. A central audible module shall provide for the necessary alarm message/tone generation, main and remote microphone connections and mixers/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure (main microphone trouble, tone trouble, etc.)

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

a) Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.

b) Programmable tone and message sequence selection.

c) Standard digitally recorded messages for "Evacuation" and "All Clear."

d) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire alarm control unit.

2. Hand held push to talk, noise canceling microphone in recessed protective panel mounted enclosure; 5 feet coiled cable; and LED to indicate the microphone push to talk has been pressed.

3. Audible power amplifiers shall be self filtered; contain 24 volt power supply, transformer and amplifier monitor circuits; Amplifier shall operate all system speakers plus twenty-five (25) percent spare capacity.

4. Digitized voice messages are required to notify building occupants during alarm conditions. Message player shall not rely on tape or mechanical means of transmitting the voice message. A standard evacuation message shall be provided; however, the system shall be capable of transmitting a custom message of up to five (5) minutes long.

5. Alarm sequence shall consist of a temporal (3) alarm tone for a maximum of 15 seconds followed by an automatic pre-selected message. At the end of the message the tone shall resume. This sequence shall continue until the fire alarm control panel has been silenced. Manual voice paging shall be available via panel switches to page individual floors or groups of floors. Each floor shall be an individual audible zone and have a corresponding audible switch.

2.06 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the central station and shall comply with UL 632.

B. Coordinate with General Contractor to ensure proper connections are provided for monitoring of the transmitter. Communication lines shall be two dedicated telephone lines, or other approved method complying with NFPA 72 and the Authority Having Jurisdiction.

C. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with supervising station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the supervising station over the remaining line. Transmitter shall automatically report telephone service restoration to the supervising station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

D. Digital data transmission shall include the following:

1. Address of the alarm initiating device.
2. Address of the supervisory signal.
3. Address of the trouble signal.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.

8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising station.

2.07 REMOTE ANNUNCIATOR

A. Description: Alphanumeric display and LED indicating lights shall match those of fire alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

1. Mounting: Flush.

2. Provide remote microphone and emergency/voice alarm system controls.

2.08 INITIATING DEVICES

A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.

2. Station Reset: Key or wrench operated switch.

3. Indoor Protective Shield: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.

1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.

2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.

3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer’s standard housing to protect the measuring chamber from damage and

insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.

1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
5. Provide remote alarm LEDs and remote test stations as shown on the plans.
6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

2.09 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.
2. Provide strobe synchronization as required per NFPA 72.
3. Wall mounted notification appliances shall be manufacturer standard white finish.
4. Ceiling mounted notification appliances shall be manufacturer standard white finish.

B. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated ¼ to 2 watts and produce 79 to 88 dB at 10 feet.

C. Atlas/Soundolier Speakers (Wall Mount): Provide voice control loudspeaker, model number APF-15TU. Model shall be a double re-entrant type with 15 watts RMS audible power rating compression driver producing a UL-rated sound pressure level of 102 dB measured at 15 watts at 10 feet, within a frequency range of 400 Hz to 4 kHz. Loudspeaker assembly shall be furnished with mounting

bracket allowing adjustment on either a vertical or horizontal plane with a single locking pin and including provisions for mounting, banding or strapping. Wiring terminals for amplifier output shall be fully enclosed and vandal-resistant adapter cover shall provide connection facilities for cable or conduit. Unit shall be finished in red baked epoxy.

D. Atlas/Soundolier Speakers (Ceiling Mounted): Atlas/Soundolier #UHT, UL listed to Standard 1480, 8-inch cone, multi-tapped design with output power of 1/2, 1, 2, 5 watt and 10 watt with either 25 or 70.7 VRMS input. Semi-flush ceiling mounted; #U51-8 standard round grille with #U95-8 enclosure (required for UL listing). Speaker output shall exceed 80 dBa at 10 feet and not exceed 120 dBa at the minimum hearing distance from the device. The speakers shall have multiple taps and shall utilize the 2-watt tap on the Atlas/Soundolier 10 watt speaker.

E. Quam UL22/25 - Lay-in Speaker: UL Listed, shallow depth, lightweight, tile replacement, fire-protective signaling device with an 8C10PAFR - 8" O.D. loudspeaker, 10 oz. magnet, fire retardant components and a 4W-25V rotary select transformer. Integral enclosure is 1,412 CID molded fiber. Grille is perforated steel with five (5) seismic tie-off points in a white powder coat ?nish. Line supervision capacitor is included. No assembly required.

F. Visible Alarm Notification Appliances (Strobes): Xenon strobe lights complying with UL 1971, unfiltered or clear filtered white light, with candela ratings as indicated on drawings. Strobes shall meet all requirements of the Americans with Disabilities Act.

2.10 AUXILIARY DEVICES

A. Waterflow Alarm Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer. Switch shall have an adjustable delay to minimize false alarms due to fluctuations in water pressure.

B. Valve (Tamper) Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer.

C. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.

D. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

E. Fire Department Key Box: Shall be by Knox Company or as otherwise specified by the authority having jurisdiction. Provide with an internal switch to indicate a

supervisory condition at the fire alarm control and annunciator panels when the lid is removed.

2.11 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.

2. Finish: Paint of color to match the protected device.

2.12 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.

B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.

C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.

D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.

E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.

F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

G. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

H. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

2.13 ACCESS TO EQUIPMENT

A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings.

2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

3. Access doors must be of the proper materials for type of construction where installed.

4. The exact location of all access doors shall be verified with the Architect prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

   a) For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.

   b) For gypsum wallboard or plaster: perforated flanges with wallboard bead.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

   a) Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.

9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

   a) Arrow United Industries.

   b) Bar-Co., Inc.

   c) J.L Industries.

   d) Karp Associates, Inc.

   e) Milcor Div. Inryco, Inc.

   f) Nystrom Building Products

   g) Wade

   h) Zurn

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall install, program and test all new equipment identified in this contract.

B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.

C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.02 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.

2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

C. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color.

The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.

D. Smoke and Heat Detectors: Provide detectors as shown on drawings.

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
2. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
3. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
4. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
5. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.

E. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.

F. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in unsprinklered elevator shafts.

G. Single Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, or valve-tamper switch that is not readily visible from normal viewing position.

I. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.

J. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.

K. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.

L. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.

3.04 PATHWAYS

A. Pathways shall be installed in conduit.

B. Minimum allowable conduit size shall be ¾ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

C. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.

D. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.

E. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.

F. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.

G. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.05 CONNECTIONS

A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated

terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC systems.
2. Alarm initiating connection to elevator recall system and components.
3. Alarm initiating connection to activate emergency lighting control.
4. Connection to disable sound systems upon alarm activation.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at low-air pressure switch of each dry-pipe sprinkler system.
7. Supervisory connections at elevator shunt-trip breaker.

3.06 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).

C. The location of end-of-line resistors shall be identified with a label indicating “EOL.”

D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

3.08 GROUNDING

A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.09 FIELD QUALITY CONTROL

A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.

1. Smoke detectors shall be tested with products of combustion.

B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.

C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:

1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

a) Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

b) Test visible appliances for the public operating mode according to manufacturer's written instructions.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire alarm system will be considered defective if it does not pass tests and inspections.

F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor's factory-trained technicians.

3.10 DEMONSTRATION

A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.

B. Demonstrate normal and abnormal modes of operation, and required responses to each.

C. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes:
1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and removing site utilities, abandoning site utilities in place.
8. Temporary erosion and sedimentation control.

B. Related Requirements:
1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.
2. Section 015639 – Temporary Tree and Plant Protection
3. Section 015713 – Temporary Erosion and Sediment Control
4. Section 312000- Earth Moving

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating and filling for rough grading the Site.
   2. Preparing subgrades for slabs-on-grade,pavements, turf and grasses, and, plants.
   3. Excavating and backfilling for buildings and structures.
   4. Drainage course for concrete slabs-on-grade.
   5. Subbase course for concrete walks, pavements.
   6. Subbase course and base course for asphalt paving.
   7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Preinstallation Conference: Conduct preexcavation conference at Project site.

1.2 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1.3 FIELD CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

B. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than **3 inches** in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch** sieve and not more than 12 percent passing a **No. 200** sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a **1-1/2-inch** sieve and not more than 8 percent passing a **No. 200** sieve.
   1. Arkansas Highway and Transportation Department Class 7 Aggregate Base Course (ABC)

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch** sieve and not more than 12 percent passing a **No. 200** sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a **1-inch** sieve and not more than 8 percent passing a **No. 200** sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch** sieve and zero to 5 percent passing a **No. 8** sieve.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, **6 inches** wide and **4 mils** thick, continuously inscribed with a description of the utility; colored as follows:

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches** wide and **4 mils** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches** deep; colored as follows:
   1. To comply with local practice or requirements of authorities having jurisdiciton.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be

performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

END OF SECTION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Perform Work in accordance with all applicable codes, and City of Bentonville Ordinances.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

3.2 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed. Basis of acceptance shall include but not be limited to compacted density performed as specified herein.
   1. Perform field density tests in accordance with ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method) or ASTM D 6938.

B. If in the opinion of the Engineer, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, Contractor shall perform additional compaction and testing, at his expense, until specified density is obtained.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Perform foundation and under floor termite control treatment in accordance with the Arkansas Pest Control Law and to qualify construction under this Contract for continuous guaranteed protection specified.

B. Applicable Regulations:
   1. International Building Code
   2. Arkansas Pest Control Law.

1.02 RELATED DOCUMENTS

A. Applicable portions of the Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to the execution of the Contract, other documents listed in the Agreement and Modifications issued after the execution of the Contract shall apply to this Section. The general requirements for this work are located in Division 1 of the Specifications.

1.03 SUBMITTALS AND SUBSTITUTIONS

A. In accordance with Section 01 3000.
   1. Copy of applicator’s state license.
   2. Proof that the proposed chemical treatment is permitted by state plant board.
   3. Copy of required 5 year Damage Guaranty Contract

B. Substitutions will not be considered prior to the award of the General Contract.

1.04 GUARANTEE

A. Furnish damage guarantee with service and re-service for any subterranean termite infestation without cost to Owner. Write Damage Guaranty Contract additionally to cover any and all subterranean termite damage to the structures and contents in amount of $10,000.00. Such damage to be repaired, replaced or corrected at Contractor's expense.

B. Furnish damage guarantee effective for 5 year period after completion of initial treatment without payment of additional fees or premiums by Owner. Upon expiration of 5-year period, Owner has option of extending damage guarantee contract at an annual fee mutually agreed upon by Owner and applicator. Owner reserves the right to cancel as of any anniversary date. Service, re-service, and Damage Guaranty provisions of the extended damage contract are noncancellable by applicator. Annual fee subject to revision by giving advance written notice to Owner.

PART 2 - PRODUCTS

2.01 TERMITE CONTROL CHEMICALS

A. Use chemicals approved by the Arkansas State Plant Board and of type required to give guaranteed protection specified.

PART 3 - EXECUTION

3.01 PREPARATION

A. From investigation at the site determine soil texture or otherwise obtain this information from the County Agent, Soil Conservation Service or other approved authorities, if not already known.

B. Remove wood and cellulose containing materials from earth sub-grade to be treated before chemical is applied.

3.02 TREATMENT

A. Perform foundation and under floor termite control treatment at buildings to be constructed under this Contract. Use type chemical approved by the Arkansas State Plant Board and currently known to give guaranteed protection for the soil and fill used at this Project. Apply chemical using applicator licensed by the Arkansas State Plant Board. Apply in sufficient quantity under and around the structures, to qualify building and contents for continuous guaranteed protection against damage by subterranean termites.

B. Reapply soil treatment solution to areas disturbed by subsequent excavation or construction activities following application.

C. Under Slabs: Apply under slabs at the rate recommended by manufacturer. Apply after placement of gravel drainage fill and immediately prior to placement of vapor barrier . When necessary to insure proper penetration, the ground surface will be left loose or lightly scarified until treatment has been completed.

D. Critical Areas: Treat a one foot strip along critical areas under walls, around interior piers and pipes rising from the ground at the rate recommended by manufacturer. Treatment shall be applied as specified for overall treatment under slabs.

E. Outside of Foundations: Apply a one foot strip along the outside of the foundations of the building at the rate recommended by manufacturer. Apply in a trench dug to a depth of approximately 2" below finish grade. Loosen earth in trench to a depth of 12" before treating. This treatment is to be performed prior to finish grading.

3.03 PROTECTION

A. Unless treated surfaces are to be immediately covered, take means necessary to prevent disturbance of treated areas by human or animal contact.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.4 FIELD CONDITIONS

A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
   1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.
   1. Maintain an accurate log of surveyed elevations and positions for comparison with

original elevations and positions.

2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:
   1. 312000 – EARTH MOVING

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Material certificates.

C. Material test reports.

D. Floor surface flatness and levelness measurements.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
   2. Manufacturer shall provide concrete mix designs stamped and sealed by a licensed professional Engineer licensed in the State of Arkansas.

B. Testing Agency Qualifications: An independent agency, approved by Owner and Engineer qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Testing Agency shall be managed by a licensed professional engineer licensed in the State of Arkansas.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

E. Concrete Testing Service: Engage and provide a qualified independent testing agency to perform material evaluation tests and to sample and test concrete mixtures.

F. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I or Type II gray. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class F or C.
      b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded.
   1. Maximum Coarse-Aggregate Size: **1 inch** nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.3 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd.** when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound-1: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
   1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
   1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage and provide a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Sample concrete materials for slump, temperature and strength testing as required by ACI 301.

C. Provide one (1) set of concrete tests for each 50 cubic yards of material or fraction thereof.

D. Concrete test samples shall include four concrete cylinders for strength testing; one to be tested at 7 day, two to be tested at 28 day, and one spare to be tested at 56 days as required.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.

B. Related Sections:
   1. Section 321123 "Aggregate Base Course" for aggregate subbase and base courses.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Design: For each job mix proposed for the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For each paving material, from manufacturer

1.4 QUALITY ASSURANCE

A. Allowable Tolerances:
   1. Subgrade after fine grading:
      a. Shall not vary more than 0.05 feet from plan elevation.
   2. Aggregate base:
      a. Shall not vary more than 0.05 feet from plan elevation.
   3. Asphalt concrete hot mix binder course:
      a. Shall not vary more than 0.04 feet from the plan elevation.
      b. Shall not vary more than 0.04 feet from specified thickness.
   4. Asphalt concrete hot mix wearing course:
      a. Shall not vary more than 0.03 feet from the plan elevation.
      b. Shall not vary more than 0.02 feet from specified thickness.
      c. Shall not vary more than 0.015 feet from the edge of a 10 foot straight edge laid thereon parallel to or at right angles to the direction of paving.
   5. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
      a. Test and Design Mix Criteria:

         1) Contractor, at his expense, shall employ the services of an independent testing laboratory to perform tests and design mixes. Materials and mix designs shall be approved at least 10 days before starting of construction

            a) Aggregate tests (Aggregate Base Course):

b) The material to be used for the aggregate base course shall conform to Section 321123, Aggregate Base Course.
c) Preliminary job mix formula (Asphalt Concrete Hot Mix Surfacing):
d) A preliminary job mix formula shall be developed for the asphalt concrete hot mix surfacing material in accordance with AASHTO MP 2 or equal to AHTD requirements.
e) Resubmit a new job mix formula for OWNER'S approval if it becomes necessary to change the source of aggregates or when unsatisfactory results or other conditions warrant a change in mixture requirements.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of **60 deg F**.
   2. Asphalt Base Course: Minimum surface temperature of **40 deg F** and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of **60 deg F** at time of placement.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIALS

A. Asphalt Bitumen for Binder Course and Surface Course: AASHTO M 320, PG 76-22

B. Bituminous Track Coat: CSS-1, CSS-1h, RC-70, MC-250, or OWNER approved equal.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROLS

A. From time to time during progress of the work and/or upon completion of the work, OWNER may require that testing be performed to determine that materials provided for the work and its installation meets the specified requirements.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

END OF SECTION

PART 1 -GENERAL

1.1 QUALITY ASSURANCE

A. Qualifications of Installers:
   1. Provide at least 1 person at all times during execution of this portion of Work and who is thoroughly familiar with the type of materials being installed and is directly responsible for all Work performed under this Section.

B. Requirements of Regulatory Agencies:
   1. It is Contractor's responsibility to comply with the requirements of the regulatory agencies, including the purchase of any permits at their own expense.

C. Construction Tolerances:
   1. Vertical alignment shall not vary more than 1/8 inch from the edge of a 10-foot straight edge.
   2. Horizontal alignment shall not vary more than 1/2 inch from the plan alignment for pavement.
   3. Concrete thickness shall not be less than specified.
   4. Reinforcing bars shall be placed to the following tolerances:
      a. Clear distance to formed surface, plus or minus ¼ inch.
      b. Sheared length, plus or minus 1 inch.
      c. Concrete cover on top bars in slabs and beams 8 inches deep or less, 2 inches plus or minus 1/4 inch.
      d. Concrete cover on top bars in members 8 inches to 24 inches deep, 2 inches plus or minus 1/2 inch.
      e. Crosswise or lengthwise spacing, plus or minus 2 inches provided minimum spacing and cover requirements are not violated.

D. Referenced Standards:
   1. The current editions of the following American Concrete Institute (ACI) publications shall govern all Work performed hereunder, unless otherwise specified:
      a. Recommended Practice for Concrete Floor and Slab Construction - ACI 302.
      b. Recommended Practice for Hot Weather Concreting – ACI 305.
      c. Recommended Practice for Cold Weather Concreting - ACI 306.
      d. Recommended Practice for Construction of Concrete Pavements and Concrete Bases - ACI 316.
      e. Building Code Requirements for Reinforced Concrete - ACI 318.

E. Design Criteria:
   1. Contractor shall employ an approved independent materials testing laboratory and pay for the service of setting up the design mixes and to analyze the fine and coarse aggregate for the various uses of concrete utilized on the project. Design mixes shall be in accordance with the previously cited ACI 318 publication and in compliance with this Specification. The proposed mixes shall be submitted to

OWNER for approval prior to placing of any concrete. The approved mixes established by the laboratory shall be used in the Work as long as the characteristics of the ingredients remain unchanged. If any significant change is made in the ingredients, new mixes shall be prepared and submitted to OWNER for approval.

2. Concrete shall consist of a minimum 28 day compressive design strength of 4,000 psi using portland cement, aggregate, air entraining admixture, water and an air content ranging from 5 to 7 percent. Slump of concrete shall have a range of 2 to 4 inches.
    a. If any of the conditions vary from those as described, Contractor shall submit a revised mix design prepared by the testing laboratory along with a written request for the variance desired to OWNER for their consideration and approval.
    b. Concrete for portions of the structure required to be watertight, such as water storage, pumpstation wetwells and waste treatment tanks, shall be air-entrained and have a water-cement ratio not exceeding 0.48.
    c. Admixtures shall be used only with the approval in writing by OWNER. All admixtures shall be used in accordance with the manufacturer's instructions and shall be added at the plant. Calcium chloride shall not be used as an admixture.
    d. Mix designs shall be based on Type I cement. Type III (high early) cement or any other types of cement shall be used only when approved in writing by OWNER. When high-early cement is used, the 7-day strength test shall exceed the specified 28-day strength tests.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Form Material:
1. Form material shall be either sound lumber or steel, free of defects and variations in dimensions. The sides of all lumber shall be surfaced and matched to prevent mortar leakage. Metal forms shall be of standard manufacture and need not be new, but shall be free from rust and dirt. Metal forms shall be flat and true to line without punctures. All form material shall be sized and of strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal of same.
    a. Rigid forms are to be utilized on tangent alignment and curves having a radius of 150 feet or greater.
    b. Curved forms shall be utilized on the curved Work with a radius of 150 feet or less, and shall consist of flexible spring steel or laminated lumber.

B. Reinforcement Materials:
1. Reinforcing bars and dowels shall be of new billet steel conforming to ASTM A615, Grade 60 (60,000 psi yield). Sizes of bars shall be as indicated on Drawings or herein specified.
    a. Dowel bars when used for contraction and expansion joints shall be smooth steel bars coated with a thin uniform coating of liquid asphalt (MC-250) or grease on 1/2 the length of the bar plus 2 inches. In addition, dowel bars for

expansion joints shall be furnished with end caps designed with one end closed, a minimum length of 3 inches and be positioned to allow bar movement of not less than 1 inch.

b. Dowel bar assemblies may be permitted if fabricated to the width of the pavement section.

c. Tie bars for control, longitudinal and construction joints shall be deformed bars.

C. Concrete Materials:

1. Portland cement shall conform to ASTM C150.
   a. Cement shall be a low alkali cement (Type I) containing not more than 0.6 percent by weight of tri-sodium silicate oxide.
2. Coarse aggregate shall conform to Size 57 grade requirements of Table 2 of ASTM C33 standard.
3. Fine aggregate shall conform to ASTM C33 with fineness modulus not to vary more than 0.20 from value assumed in design mix.
4. Water shall be potable, clean and free from deleterious amounts of acid, alkali or organic material.

D. Admixtures:

1. Air entraining agent shall conform to ASTM C260 and shall be added at the mixer.
2. Water reducing agents, (such as super plasticizers), retarding agents, accelerating agents and all other admixtures, shall require approval by OWNER and if used, shall conform to ASTM C494. In no case shall admixtures be permitted as substitute for cement content specified, unless approved by OWNER.

E. Expansion Joint Material:

1. Joint filler material shall consist of a non-extruding standard bituminous bound type "Sealtight Asphalt Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois or OWNER approved equal.
   a. Material shall conform to ASTM D994.
2. Joint filler material shall consist of preformed non-extruded bituminous bound type "Sealtight-Fibre Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois; "Code 1390" as manufactured by W.R. Grace Company, Cambridge, Massachusetts or OWNER approved equal.
   a. Material shall conform to ASTM D1751.
   b. Material shall be 1/2 inch thick, unless otherwise noted, of widths equal to slab thickness less 1/2 inch or as otherwise indicated.
3. Joint sealant shall be a single component, polyurethane type "Sikaflex-la" as manufactured by Sika Chemical Corporation, Lyndhurst, New Jersey or OWNER approved equal. Color as selected by OWNER.

F. Curing Materials:

1. Kraft paper shall be waterproof and nonstaining "Sisalkraft 5K-10" conforming to ASTM C171.
2. Polyethylene film shall be white opaque sheet or roll material not less than 0.006 inch thick (6 mil) conforming to AASHTO-M171.
3. Contractor may at their option use a liquid curing compound for surfaces that will not receive treating oil or waterproofing membrane. Liquid curing compound shall conform to ASTM C309 and shall consist of the following:

a. Type 1D, translucent with fugitive dye.
b. Type 2, white pigmented, Class B (vehicle solids restricted to all resin).

PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
1. Concrete Pavers
2. Joint Sand
3. Setting Bed Sand
4. Base Aggregate
5. Subbase Aggregate

1.02 REFERENCES

Note: Design street, industrial, port and airport pavement thicknesses in consultation with a qualified civil engineer, in accordance with established flexible pavement design procedures, and in accordance with Interlocking Concrete Pavement Institute Technical Bulletins.

ASTM International, latest edition:
1. C 33, Standard Specification for Concrete Aggregates.
2. C 136, Standard Test Method for Sieve Analysis of Fine and Course Aggregates.
3. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
5. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
6. C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
7. C 979, Standard Specification for Pigments for Integrally Colored Concrete.
8. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
9. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
10. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
11. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.

1.03 SUBMITTALS

A. Concrete Pavers:
1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion. Alternate size samples to represent colors and textures will be acceptable for production approval.
2. Accepted samples become the standard of acceptance for the product produced.
3. Test results from an independent testing laboratory for compliance

of concrete pavers with ASTM C 936.

4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

B. Setting Bed Sand:
   1. Provide three representative one pound samples in containers of Setting Bed Sand materials.
   2. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.

C. Polymeric Joint Sand:
   1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.
   2. Samples for Initial Selection: Provide three representative samples in sample sleeves of Polymeric Joint Sand material, cured and dried, for color selection.
   3. Samples for Verification: Correct material to be used in job panel for approval.

D. Base and Subbase Aggregate:
   1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136.

E. Paving Installation Contractor:
   1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

1.04 QUALITY ASSURANCE

A. Utilize a Manufacturer having at least ten years of experience manufacturing concrete pavers on projects of similar nature or project size.

B: Source Limitations:
   1. Obtain Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.
   2. Paver must include Unilock's Enduracolor™ and EasyClean Technology™ in all pavers.
   3. Obtain Setting Bed Sands from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.
   4. Obtain Polymeric Joint Sand from Antique Brick & Block Jason Garner Jason@antiquebrickinc.com or Adam McPike adam@antiquebrickinc.com 501-680-0450 Alliance Gator G2 Maxx Joint Sand (Color TBD)

C. Paving Contractor Qualifications:

1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.

D. Mockups:
1. Install a 5 ft x 5 ft paver area per each paving pattern.
2. Use this area to determine surcharge of the Setting Bed Sand layer, joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.
3. Subject to acceptance by owner, mock-up may be retained as part of finished work.
4. If mock-up is not retained, remove and dispose legally.

1.05 DELIVERY, STORAGE & HANDLING

A. In accordance with Conditions of the Contract and Division 1 Product Requirement Section.

B. Deliver Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
2. Deliver Concrete Pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
3. Unload Concrete Pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.

C. Store and protect materials free from mud, dirt and other foreign materials.

D. Prevent Joint and Setting Bed Sand from exposure to rainfall or removal by wind with secure, waterproof covering.

E. Store Polymeric Joint Sand on elevated platforms, under a cover and/or in a dry location.

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
1. Install Concrete Pavers only on unfrozen and dry Setting Bed Sand.
2. Install Setting Bed Sand only on unfrozen and dry Base or Subbase Aggregate materials.
3. Install Base or Subbase Aggregates only over unfrozen subgrade.
4. Install Setting Bed Sand or Concrete Pavers when no heavy rain or snowfall are forecast within 24 hours.

1.07 CONCRETE PAVER OVERAGE AND ATTIC STOCK

A. Provide a minimum of 5% additional material for overage to be used during construction.

B. Contractor to provide 100 square feet of each product and size used to owner for maintenance and repair. Furnish Pavers from the same

production run as installed materials.

C. Manufacture to supply maintenance and reinstatement manuals for Concrete Paver units.

PART 2 – PRODUCTS

2.01 CONCRETE PAVERS

A. Basis-of-Design Product: The Concrete Paver shapes are based on:
   1. Unilock:
      a. Unilock 12x36x4 (300x900x100)
   2. As manufactured by: Unilock Aurora, IL
      Contact: Jason Garner Jason@antiquebrickinc,com or Adam McPike adam@antiquebrickinc.com 501-680-0450
   3. Substitutions: No substitutions permitted.

B. Product requirements:
   1. Concrete Paver Type 1: Unilock 12x36x4 (300x90x100)
      a. Finish: Premier Smooth
      b. Color: Unilock Blend #319 With EnduraColor™ and EasyClean Technology™
      c. Edge: Micro Chamfer with integral lug
      d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch. Note: Imperial dimensions are nominal equivalents to the metric dimensions.
   2. Concrete Paver Type 2: Unilock 12x36x4 (300x90x100)
      a. Finish: Premier Shot Blast
      b. Color: Unilock Blend #319 With EnduraColor™ and EasyClean Technology™
      c. Edge: Micro Chamfer with integral lug
      d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch. Note: Imperial dimensions are nominal equivalents to the metric dimensions.

C. Provide pavers meeting the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.
   1. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).
   2. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.
   3. Conforming to ASTM C 1645 when tested for freeze-thaw requirements.
   4. Height tolerances +/- 3.2 mm (1/8 in).

D. Accept only pigments in concrete pavers conforming to ASTM C 979. Note: ACI Report No. 212.3R provides guidance on the use of pigments.

E. Maximum allowable breakage of product is 5%.

2.02 POLYMERIC JOINT SAND

A. Provide Polymeric Joint Sand as manufactured by: Antique Brick & Block
   1. Alliance Gator G2 MAXX
      a. Product Type: Dry mix, contains polymeric binding agent, activated with water.
      b. Color: (TBD from manufacturer standard colors)

B. Provide Polymeric Joint Sand meeting the minimum material and physical properties as follows:
   1. Compression Strength: proven resistance to compression of 300 PSI minimum after drying for 7 days under controlled conditions (73°F (23°C) at 50% humidity).
      a. Test sand sample shape: cylinder (2" (5 cm) dia. X 4" (10 cm) high).

2.03 SETTING BED SAND

A. Provide Setting Bed Sand as follows:
   1. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
   2. Do not use limestone screenings, stone dust, or sand material that does not conform to conform to the grading requirements of ASTM C 33.
   3. Do not use mason sand or sand conforming to ASTM C 144.
   4. Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic.
   5. Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 2 below:

TABLE 2 – SETTING BED SAND GRADATION REQUIREMENTS FOR SETTING BED SAND

ASTM C 33	
Sieve Size	**Percent Passing**
3/8 in (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	2 to 10
No. 200 (0.075)	0 to 1

Note: Coarser sand than that specified in Table 1 above may be used for joint sand including C 33 material as shown in Table 2. Use material where the largest sieve size easily enters the smallest joints. For example, if the smallest paver joints are 2 mm wide, use sand 2

mm and smaller in particle size.

2.04 BASE AGGREGATE

A. Provide Base Aggregate materials conforming to ASTM D 2940 and gradation requirements as presented in Table 3.

TABLE 3 BASE AGGREGATE GRADATION REQUIREMENTS

ASTM D 2940	
Sieve Size	**Percent Passing**
2 in (50 mm)	100
1-1/2 in (37.5 mm)	95 to 100
3/4 in (19 mm)	70 to 92
3/8 in (9.5 mm)	50 to 70
No. 4 (4.75 mm)	35 to 55
No. 30 (600 µm)	12 to 25
No. 200 (75 µm)	0 to 8*

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.05 SUBBASE

A. Reference Detail 2, sheet C5.02.

B. Provide Subbase Aggregate as designed per the structure engineer.

C. Insert gradation requirements here.

2.06 GEOTEXTILE

A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
   1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
   2. Grab Tensile Strength: ASTM D 4632: 115 lbs.
   3. Grab Tensile Elongation: ASTM D 4632: 50%
   4. Trapezoidal Tear: ASTM D 4533: 50 lbs.
   5. Puncture: ASTM D 4833: 65 lbs.
   6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve
   7. Permittivity: ASTM D 4491: 2.0 sec -1
   8. Flow Rate: ASTM D 4491: 140 gal/min/s.f.

B. As supplied by Antique Brick & Block
   Contact: Adam Mcpike adam@antiquebrickinc.com 501-680-0450
   1. Geostar Geogrid specification.

2.07 EDGE RESTRAINTS

A. Metal Edge Restraint
   1. Weathering steel, ¼" thickness, 8" wide, length per plan

Note: The provision of suitable edge restraints is critical to the satisfactory performance of interlocking concrete block pavement. Abut pavers tightly against the restraints to prevent rotation under load and any consequent spreading of joints. Install sufficiently stable edge restraints that are, in addition to providing suitable edge support for the paver units, able to withstand the impact of temperature changes, vehicular traffic and/or snow removal equipment.

Curbs, gutters or curbed gutter, constructed to the dimensions of municipal standards (noting that these standards generally refer to cast-in-place concrete sections), are considered to be acceptable edge restraints for heavy duty installations. Where extremely heavy industrial equipment is involved such as container handling equipment, review the flexural strength of the edge restraint carefully particularly if a section that is flush with the surface is used and may be subjected to high point loading.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Concrete Pavers.
   1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
   2. Verify that Geotextiles, if applicable, have been placed according to drawings and specifications.
   3. Verify that the Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
   4. Provide written density test results for soil subgrade, Base and Subbase Aggregate materials to the Owner, General Contractor and paver installation subcontractor.
   5. Verify location, type, and elevations of edge restraints, concrete curbing, concrete collars around utility structures, and drainage inlets.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Beginning of Bedding Sand and Concrete Paver installation signifies acceptance of Base and edge restraints.

3.02 PREPARATION

A. Verify that the subgrade soil is free from standing water.

B. Stockpile Setting Bed Sand, Joint Sand, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free

of any organic material or sediment, debris, and ready for placement.

C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Subbase Aggregate materials.

D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Joint Sand, Setting Bed Sand, Base and Subbase Aggregate materials contaminated with sediment with clean materials.

E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Base or Subbase Aggregate construction.

F. Prevent to damage underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.

G. Compact soil subgrade uniformly to at least 95 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 98 percent Modified Proctor per ASTM D 1557 for vehicular areas. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils.

H. Backfill all service trenches within the pavement area to the sub- grade level with approved material placed in uniform lifts not exceeding 4 in. (100 mm) loose thickness. Compact each lift to at least 95 percent Standard Proctor Density as specified in ASTM D 698.

I. Trim the subgrade to within 0 to ½ in. (0 to 13mm) of the specified grades. Do not deviate the surface of the prepared subgrade by more than 3/8 in. (10mm) from the bottom edge of a 39 in. (1m) straight edge laid in any direction.

J. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill or fill as directed.

K. Do not proceed with further pavement construction, under any circumstances, until the subgrade has been inspected by the Architect/Engineer.

Note: Base compaction of the subgrade soil on the recommendations of the Design Engineer. Request the Architect/Engineer to inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

Note: Mechanical tampers (jumping jacks) are recommended for compaction of soil subgrade and aggregate base around lamp standards, utility structures, building edges, curbs, tree wells and other protrusions. Compact areas, not

accessible to roller compaction equipment, to the specified density with mechanical tampers. **CAUTION** – Proceed with care around the perimeters of excavations, buildings, curbs, etc. These areas are especially prone to consolidation and settlement. Do not place wedges of backfill in these areas. If possible particularly in these areas, proceed with backfilling and compacting in shallow lifts, parallel to the finished surface.

3.03 INSTALLATION

EDGE RESTRAINTS

1. Provide concrete edge restraints as indicated.
   a. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete."
   b. Provide concrete edge restraint along the perimeter of all paving as indicated. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.
   c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in (150 mm) thick.

2. Provide plastic or metal edge restraints as indicated. (Delete if not being used).
   a. Provide plastic or metal edge restraints along the perimeter of all paving as indicated and supported on a minimum of 6 inches (150 mm) of Base Aggregate.
   b. Provide 10” spiral galvanized or stainless steel spike to fasten plastic edge restraint at 24 inches on center for straight sections and 12 inches on center for curved sections.

A. GEOTEXTILES

1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.
2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.

B. BASE AND SUBBASE AGGREGATE

1. Provide the Subbase Aggregate in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compact to at least 100 percent Standard Proctor Density as per ASTM D 698.
2. Compact the Subbase Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
3. Tolerance: Do not exceed the specified surface grade of the compacted Subbase Aggregate material more than ±3/4 in. (20 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
4. Provide the Base Aggregate material in uniform lifts not exceeding 6

in. (150 mm) over the compacted Subbase Aggregate (or Subgrade) material and compact to at least 95 percent Standard Proctor Density as per ASTM D 698.

5. Compact the Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
6. Tolerance: Do not exceed the specified surface grade of the compacted Base Aggregate material more than ±3/8 in. (10 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
7. Compact and grade the upper surface of the base sufficiently to prevent infiltration of the bedding sand into the base both during construction and throughout its service life. Blend segregated areas of the granular base by the application of crushed fines that have been watered and compacted into the surface.

C. SETTING BED SAND

1. Provide, spread and screed Setting Bed Sand evenly over the compacted Base Aggregate course.
   a. Protect screeded Setting Bed Sand from being disturbed by either pedestrian or vehicular traffic.
   b. Screed only the area which can be covered by pavers in one day.
   c. Do not use Setting Bed Sand material to fill depressions in the base surface.
2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.
3. Screed Setting Bed Sand using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards. Maintain in a loose condition slightly ahead of the paving units and fully protect against incidental compaction following screeding. Loosen compacted sand by rain or screeded sand left overnight before further paving units are placed.
4. Inspect the Setting Bed Sand course prior to commencing the placement of the Concrete Pavers. Acceptance of the Setting Bed Sand occurs with the initiation of Concrete Paver placement.

D. CONCRETE PAVERS

1. Replace Concrete Pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
2. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project). Exercise care in

handling face mix concrete pavers to prevent surfaces from contacting backs or edges of other units.

3. Provide Concrete Pavers using laying pattern as indicated. Adjust laying pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
4. Use string lines or chalk lines on Setting Bed Sand to hold all pattern lines true.
5. Set paver surface elevation a minimum of 3 mm (1/8 inch) to a maximum of 6 mm (1/4 inch) above adjacent drainage inlets, concrete collars or channels (provided the change in slope does not impede or alter the drainage or direction of flow).
6. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.
7. Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.
8. Prevent joint (bond) lines from shifting more than ±1/2 in. (±13 mm) over 50 ft. (15 m) from string lines.
9. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
10. Cut Concrete Pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
11. Prevent all traffic on installed Concrete Pavers until Joint Sand has been vibrated into joints. Keep skid steer and forklift equipment off newly laid Concrete Pavers that have not received initial compaction and Joint Sand material.
12. Vibrate Concrete Pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
    a. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
    b. Compact installed Concrete Pavers to within 6 feet (2 meters) of the laying face before ending each day's work. Cover Concrete Pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Setting Bed Sand from becoming disturbed.
13. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.
14. Remove any cracked or structurally damaged Concrete Pavers and replace with new units prior to installing Joint Sand material.

E. JOINT SAND

1. Polymeric Joint Sand
    a. Install Polymeric Joint Sand per manufacturers recommended instructions.

F. FIELD QUALITY CONTROL

1. Verify final elevations for conformance to the drawings after sweeping the surface clean.
2. Prevent final Concrete Paver finished grade elevations from deviating more than ±3/8 in. (±10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.

G. LIPPAGE: PAVER-TO-PAVER LIPPAGE:

1. No greater than 3 mm (1/8 inch) difference in height between adjacent pavers. *Note: The industry standard acceptable lippage between adjacent pavers is 3 mm (1/8 inch). Achieving a completely flush paver surface is most desirable but may be unattainable depending on factors such as paver type, setting bed materials or depth, ASTM manufacturing standards or other specific project needs.*

3.05 REPAIRING, CLEANING AND SEALING

Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.

Clean Concrete Pavers in accordance with the manufacturer's written recommendations.

3.06 PROTECTION

Protect completed work from damage due to subsequent construction activity on the site.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.
   3. Joint-sealant backer materials.
   4. Primers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: for each type of product

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

C. Paving-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 JOINT-SEALANT BACKER MATERIALS

A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

PART 3 - EXECUTION

3.1 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.

D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

E. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backer materials.
   2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
   3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

F. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:
   1. Place joint sealants so they fully contact joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. Provide steel fence framing and ornamental fences and gates of the following type:

Choose applicable fence and gate components from the following:

1. Wire mesh fence panels. Other Infill System.
2. Inclined section (formed main bar) fence panels.
3. Swing gates matching adjacent fence panels.
4. Sliding gates matching adjacent fence panels.

B. Related Work Specified Elsewhere:

1. Concrete Work: Section ____03 3000_____

2. Motor Operator For Gates: Section ___?__
3. Electrical Work In Connection With Motor Operated Gates: Division 16 ELECTRICAL.

1.2 PERFORMANCE CHARACTERISTICS

A. Polyester Powder Coating:

1. Salt Spray Resistance: When tested in accordance with ASTM B117, Bonderite 1000 steel panels, in a scored condition, exhibit no undercutting after 500 hours in 5 percent salt spray testing at 95 degrees F and 95 percent relative humidity. No rusting or blistering on panel face. Under the same conditions after 1000 hours, the panels showed less than 3/16 inch undercutting.

2. Weatherability: When tested in accordance with ASTM D822, with one year exposure in South Florida, with panels facing south and tilted at a 45 degree angle, a high gloss white polyester coating retains 88 percent of its gloss (gloss reading obtained on washed panels). No film failure.

3. Hardness: 2 H (min) when measured in accordance with ASTM D3363.

4. Direct Impact: Up to 160 in./lbs. when measured in accordance with ASTM D2794.

B. Polyurethane Coating: Tests below conducted on Bonderite 1000 panels at 1.0 mil dry film thickness, cured for 30 minutes at 180 degrees F and aged 14 days at room temperature (25 degrees C). Results of each test: Excellent or no failure.

1. 5 percent salt spray: 500 hours.
2. 100 percent relative humidity: 1000 hours.
3. Water immersion: 100 hours.
4. Lacquer thinner, acetone, MEK, gasoline, xylene - 20 double rubs with saturated cloth.
5. Lubricating oils, hydraulic fluids, and cutting oils.

6. Cold Check: 16 cycles, 24 hours at 100 percent humidity; 24 hours at 10 degrees F; 24 hours at 77 degrees F.
7. Pencil Hardness: H to 2H.
8. Flexibility: 1/8 inch conical mandrel.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for ornamental fences and gates.

B. Samples: For each fence panel type selected, submit one representative sample approximately 8 inches by 10 inches, showing fabrication workmanship and selected coating color.

C. Shop Drawings: Submit shop drawings for ornamental fences and gates, including plan layout and details illustrating fence height, location and sizes of support posts, footing requirements, gates and gate hardware.

If specifying motor operated gates, retain the following paragraph.

1. For motor operated gates, include details of provisions to accommodate motor operator components.

1.4 WARRANTY

A. MFR Manufacturing Corp., warrants that its fencing systems are free from defects in material and workmanship. The polyester-coated and galvanized metal is guaranteed not to rust for a period of 20 years. Accidental damage, defects resulting from improper installation and damage from vandalism or abuse are not included. Warranty is limited to prorated value of the coating, not to exceed the original value of the coating.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Fences and Gates: Obtain each color, grade, finish, type, and variety of component for fences and gates from one source with resources to provide fences and gates of consistent quality in appearance and physical properties.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Standard: Provide gate operators that comply with UL 325.

E. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than [two] <Insert number> days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

B. Field Measurements: Verify layout information for fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gate System
   a. MFR Manufacturing Corp, Inc..
      1065 Sill Ave
      Aurora, IL 60506
      TEL: 815-552-3333 FAX: 815-552-3315
      Website: www.mfrcorp.com e-mail: info@mfrcorp.com

2.2 GATES

A. This Section includes the following:

1. Single swing gate.
2. Double swing gate.
3. Single Horizontal slide gate.
4. Double Horizontal slide gate.

B. Metal Tubing framed gates, to match panel system. Steel. galvanized and powder polyester coated after fabrication.

1. Gate Height: _7’-6”?__ feet.

C. Hardware: Latches permitting operation from both sides of gate, hinges, [center gate stops] and, for each gate leaf more than 5 feet (1.5 m) wide, keepers. <Insert other hardware items and accessories.> [Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.]

1. <Insert requirements for padlocks and chains if not Owner furnished.>

D. Slide Gate Track Assembly: Manufacturer's standard track, with framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

E. Guide Posts and Roller Guards.

2.3 GATE OPERATOR

A. General: Provide factory-assembled automatic gate operation system designed for gate size, type, weight, construction, use, traffic-flow patterns, and operation frequency. Provide operation system for gate specified, of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended [and provided]by gate manufacturer complete with electric motor and factory-prewired motor controls, remote-control stations, control devices, power disconnect switch, obstruction detection device, lockable weatherproof enclosures protecting controls and all operating parts, and accessories required for proper operation. Provide enclosures with corrosion-resistant-protective and decorative finish and two keys per lock. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide operator with UL [approval] [-approved components].
3. Provide electronic components with built-in troubleshooting diagnostic feature.
4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Comply with NFPA 70.

C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.

D. Electrohydraulic Operation: Provide unit designed for [gate] [surface] [concrete base/pad] [pedestal] [post] <Insert mounting> mounting; consisting of electric motor, pump, hydraulic actuator to suit gate type, valves, [heater to maintain constant temperature,] and [cold-weather] hydraulic fluid[; with hydraulic locking in both directions].

E. Electromechanical Operation: Provide unit designed for [gate] [surface] [concrete base/pad] [pedestal] [post] <Insert mounting> mounting; consisting of electric motor and factory-prewired motor controls, starter, speed control device, chain-drive assembly, [brake,] clutch or torque limiter, and as follows:

1. Enclosed worm gear reducer, roller chain drive.
2. Enclosed worm gear and chain and sprocket reducers, roller chain drive.
3. V-belt and [worm gear] [chain and sprocket] reducers, roller chain drive.
4. Enclosed worm gear reducer, wheel and rail drive.

F. Operation Cycle Requirements: Design gate operator to operate for not less than the

following duty and cycles per hour. One cycle equals one gate opening plus one gate closing.

1. Medium Duty: 10 cycles per hour.
2. Heavy Duty: 25 cycles per hour.
3. Peak Duty: 20 cycles per hour at peak periods.
4. <Insert requirements for duty and cycles per hour or day.>

G. Gate Operation Speed: [Minimum 45 fpm (0.229 m/s)] [Minimum 60 fpm (0.305 m/s)] <Insert speed>.

H. Electric Motors: High-starting torque, [reversible,] [single-direction,] continuous-duty, insulated electric motors, complying with NEMA MG 1, sized to start and operate size and weight of gate considering Project's service conditions without exceeding nameplate ratings or considering service factor.

1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
2. Enclosure: [Totally enclosed, nonventilated or fan-cooled motors, fitted with plugged drain] <Insert another enclosure>.
3. Thermal Protection: Internal [manual] [automatic] reset.
4. Motors Smaller Than 1/2 hp: [Single phase] [Polyphase], <Insert voltage rating,> 60 Hz. [Motor horsepower as recommended by operator manufacturer] [Motor horsepower as indicated on Drawings] <Insert motor horsepower>.
5. Motors 1/2 hp and Larger: Polyphase, <Insert voltage rating,> 60 Hz. [Motor horsepower as recommended by operator manufacturer] [Motor horsepower as indicated on Drawings] <Insert motor horsepower>.

I. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with [NEMA ICS 6, Type 1] [NEMA ICS 6, Type 4] <Insert another type of enclosure> enclosure for [surface] [recessed or flush] [concrete base/pad] [pedestal] [post] <Insert mounting> mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

1. Control Station: Keyed, two-position, switch-operated control station located remotely from gate, with on and off functions. Provide two keys per station.
2. Control Station: Keyed, three-position, switch-operated control station with open and close functions and spring return to off position [with stop button]. Provide two keys per station.
3. Control Station: Momentary-contact, single-button-operated control station with open and close functions.
4. Control Station: Momentary-contact, three-button-operated control station with open, close, and stop positions, [and with key switch to lock out open and close buttons. Provide two keys per station].
5. Card Reader: Functions only when authorized card is presented. Magnetically coded, single-code system activated by coded card [and permitting four different access time periods]. Provide insertion-reader-type, face-lighted unit fully visible at night.
6. Card Reader: Functions only when authorized card is presented. Easily programmable, multiple-code capability permitting validating or voiding of individual cards [and permitting four different access time periods]. Provide face-lighted unit fully visible at night.

    a. Reader Type: [Touch plate] [Swipe] [Insertion] [Proximity].

b. Features: [Timed anti-passback] [Limited-time usage] [Capable of monitoring and auditing gate activity].

7. Digital Keypad Entry Unit: Functions only when authorized code is entered. Multiple-code capability of not less than [5] [100] [500] <Insert another number to suit Project> possible individual codes.
8. Digital Keypad Entry Unit: Functions only when authorized code is entered. Easily programmable, multiple-code capability permitting validating or voiding of not less than [100] [2500] [10,000] <Insert another number to suit Project> possible individual codes, consisting of [1 to 6] <Insert number> digits, [and permitting four different access time periods]. Provide face-lighted unit with [metal-keyed] [keyless-membrane] keypad fully visible at night.

   a. Features: [Timed anti-passback] [Limited-time usage] [Capable of monitoring and auditing gate activity].

9. Radio Control: Digital system consisting of code-compatible universal coaxial receiver, [one per gate] [where indicated on Drawings], remote antenna with coaxial cable and mounting brackets, and [one permanently mounted] [four portable] <Insert number and use condition to suit Project> transmitter[s] per receiver designed to operate gates. Provide easily programmable transmitter with multiple-code capability permitting validating or voiding of not less than [1000] [10,000] <Insert another number to suit Project> codes per channel configured for the following functions:

   a. Transmitters: Single-button operated, with open function.
   b. Transmitters: Single-button operated, with open and close functions.
   c. Transmitters: Three-button operated, with open, close, and stop functions.

      1) Provide transmitters featuring [two] [three] [four] <Insert another number to suit Project> independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

10. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator [auxiliary keypad entry].

    a. Residential System: Designed to be wired to same line with telephone.
    b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access [20] [100] <Insert number> telephones [and with electronic directory].

11. Vehicle Loop Detector System: System including automatic closing timer with adjustable time delay before closing [timer cut-off switch] and loop detector designed to [open and close gate] [hold gate open until traffic clears] [reverse gate] <Insert function>. Provide electronic detector, with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.

a. Loop: Wire, in size indicated for field assembly, and sealant; style for [pave-over] [saw-cut] installation.
b. Loop: Factory preformed in size indicated; style for [pave-over] [saw-cut] installation.

12. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing [timer cut-off switch] and presence detector designed to [open and close gate] [hold gate open until traffic clears] [reverse gate] <Insert functions>. Provide [retroreflective] [emitter/receiver] type detector, with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway by interrupting an infrared beam in zone pattern and to emit a signal activating the gate operator.

J. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
2. Action: Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction.
3. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
4. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using [take-up cable reel] [self-coiling cable] [gate edge transmitter and operator receiver system].

a. Along entire gate leaf leading edge.
b. Along entire gate leaf trailing edge.
c. Across entire gate leaf bottom edge.
d. Along entire length of gate posts.
e. Along entire length of gate guide posts.
f. Where indicated on Drawings.
g. <Insert extent and location.>

5. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in partition's path by interruption of an infrared beam in the zone pattern without obstruction contacting gate.

K. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

L. Emergency Release Mechanism: Quick disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Design system so control circuit power is disconnected during manual operation.

1. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.
2. Type: Mechanical device, key, or crank-activated release.

M. Operating Features: Include the following:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features [with capability of monitoring and auditing gate activity]. Provide unit that is isolated from voltage spikes and surges.
2. Fully Systems Compatible: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing [and timer cut-off switch].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: [24-hour] [Seven-day] <Insert time period> programmable for regular events.

N. Accessories: Include the following:

1. Mounting kit [including pedestal].
2. Audio Warning Module: Provide ADA-compliant audible alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
3. Visual Warning Module: Provide ADA-compliant visible [constant-] [strobe-]light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
4. Battery Backup System: Battery-powered drive and access control system, independent of primary drive system, opening gate if power fails. <Insert additional requirements.>
5. External electric-powered lock with delay timer allowing time for lock to release before gate operates.

    a. Type: [Solenoid] [Magnetic] for swing gate.
    b. Type: [Solenoid] [Magnetic] for slide gate.

6. [Fire] [Postal] box.
7. Fire [strobe] [siren] sensor.
8. Intercom System: <Insert requirements.>
9. Instructional, Safety, and Warning Labels and Signs: [According to UL 325] [Manufacturer's standard for components and features specified] [As indicated on Drawings] <Insert requirements>.

2.4 CAST-IN-PLACE CONCRETE

A. General: Comply with ACI 301 for cast-in-place concrete.

B. Materials: Portland cement complying with ASTM C 150 <Insert type if required>, aggregates complying with ASTM C 33, and potable water [for ready-mixed concrete complying with ASTM C 94]. [Measure, batch, and mix Project-site-mixed concrete according to ASTM C 94.]

1. Concrete Mixes: Normal-weight concrete [air entrained] with not less than 3000-psi (20.7- MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-

mm) maximum size aggregate.

C. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to manufacturer's written instructions.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

2.6 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material Above Finished Grade: [Copper] [Aluminum].
2. Material On or Below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Ground Rods: Listed in UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Ground Rods: Copper-clad steel.

a. Size: 5/8 inch by 96 inches (16 by 2400 mm).

2.7 SITE FENCE:EXPANDED METAL MESH WEATHERING STEEL PANELS ON WEATHERING STEEL 4X4 POSTS. LIGHT GAUGE WEATHERING STEEL SUBFRAMING, W/PEDESTRIAN GATE

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for [a verified survey of property lines and legal boundaries,] site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil. Set posts in concrete footing. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Using mechanical devices to set posts is not permitted. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured.

1. Dimensions and Profile: As indicated on Drawings.

2. Dimensions and Profile: 12” diameter for terminal posts, 10” diameter for intermediate posts. Concrete to be 6” deeper than post length in ground.
3. Exposed Concrete Footings: Extend concrete 2 inches (50 mm) above grade, smooth, and shape to shed water.
4. Concealed Concrete Footings: Stop footings [2 inches (50 mm)] <Insert dimension> below grade [as indicated on Drawings] to allow covering with surface material.
5. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [nonshrink, nonmetallic grout,] [anchoring cement,] mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
6. Posts Set into Concrete in Voids: Form or core drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [nonshrink, nonmetallic grout,] [anchoring cement,] mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

7. Mounting Plate Installation: Bolt mounting plates attached to each post to slab or structure as indicated, using expansion bolts.

3.4 GATE INSTALLATION

A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GATE OPERATOR INSTALLATION

A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation for [Support Posts] [Pedestals] [Concrete Bases/Pads]: Hand-excavate holes for bases/pads, in firm, undisturbed or compacted soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated on Drawings.

C. Concrete Bases/Pads: Cast-in-place or precast concrete, made of not less than 3000-psi (20.7-MPa) compressive strength (28 days), [depth not less than 12 inches (300 mm)] <Insert depth 6 to 12 inches (150 to 300 mm) below frost line or detail on Drawings>, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

D. Vehicle Loop Detector System: [Cut grooves in pavement and] bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

E. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.6 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of [1500 feet (450 m)] <Insert a lesser distance where grounding resistance is high> except as follows:

1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [750 feet (225 m)] <Insert a lesser distance where grounding resistance is unusually high>.

    a. Gates and Other Fence Openings: Ground fence on each side of opening.

        1) Bond metal gates to gate posts.
        2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a ground rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized.

Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

A. Ground-Resistance Testing Agency: [Owner will engage] [Engage] a qualified independent testing agency to perform field quality-control testing.

B. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by two-point method according to IEEE 81.

C. Desired Maximum Grounding Resistance Value: 25 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify Architect promptly. Include recommendations to reduce ground resistance and proposal to accomplish recommended work.

E. Report: Prepare test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, [alarms,] and limit switches.

1. Electrohydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Operational Test: After electrical circuitry has been energized, start units to confirm

proper motor rotation and unit operation. Test controls[, alarms,] and safeties. Remove damaged and malfunctioning units, replace with new units, and retest.

C. Lubricate hardware[, gate operator,] and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.

1. Test and adjust [operators,] [controls,] [alarms,] [safety devices,] hardware, and other operable components. Replace damaged or malfunctioning operable components.
2. Train Owner's personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
4. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
5. Schedule training with Owner[, through Architect,] with at least seven days' advance notice.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment and instructions necessary for the complete installation of the landscape irrigation systems as drawn and specified. The work includes, but is not limited to:
   1. Trenching, backfilling, and compaction for irrigation lines.
   2. Provisions and installation for a turnkey automatic sprinkler system. Provide Controller, Sleeving, Piping, Heads, Drip Tubing, Valves, Quick Couplers, Valve Access Boxes, Low Voltage Wiring, applicable connection fees and all other items required for a complete system as shown on the Drawings, called for in the specifications or as may be required for proper operation of the system. The system shall be installed in strict accordance with all applicable codes, ordinances and regulations.
   3. Test all systems, make operative and adjust.
   4. Submit As-Built Record Drawings, Maintenance Manual and satisfactory evidence to show that all work has been installed in accordance with the ordinance and code requirements.
   5. Maintain and operate until substantial completion.
   6. One-year Guarantee Period.

B. Related work by others:
   1. General Contractor shall provide 1” Irrigation Water Meters, 1-1/2” Service Lines To Indoors, 1” Backflow Preventers In Riser Rooms, 1-1/2” Service Lines To Outdoors and 1-1/2” Gate Valves to be considered the POC - Points-Of-Connection for the Irrigation Contractor as shown on the drawings. The General Contractor shall be responsible for coordinating the application for the water meters with the city and for providing the permit fees. All materials, operations, installed conditions and personnel shall be in strict accordance with all applicable codes, ordinances and regulations.
   2. Sch40 PVC Sleeves as provided by General Contractor (See 3.3).
   3. Electrical work and Conduit as provided by Electrical Contractor for the Automatic Controllers (See 3.8 B).

C. Provide Drip Irrigation Zones as indicated assure 100% coverage. Lay out the system so that the shrub and groundcover beds are on separate zones as feasible.

D. Coordinate exact locations of water meter, backflow preventer, controller and sensors with the Architect and General Contractor.

E. The Contractor shall coordinate the installation of the sprinkler system with the landscape installation, avoiding the rootballs of trees and shrubs.

F. The Contractor shall install the irrigation system in accordance with the schedule requirements provided by the General Contractor.

PART 2 - PRODUCTS

2.1 GENERAL

A. The sprinkler system design shall be based on the equipment of HUNTER INDUSTRIES, NETAFIM or approved equal.

B. Materials shall be newly manufactured and without flaws or defects, and of quality and performance as specified. Excess materials at completion are property of the Contractor, to be removed from the site.

C. The Contractor shall be responsible for computing and supplying the required quantities necessary to make the irrigation system complete and operational in every way. Quantities shown on the drawings are for convenience only.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Never install PVC pipe when there is water in the trench. Never install PVC pipe when the temperature is 32 degrees Fahrenheit or below.

B. Install the mainline at a bury depth of 18 inches and the lateral lines at a bury depth of 12 inches below finished grade. Maintain a 4 inch clearance between pipes that cross at an intersection and a 2 inch clearance between pipes that are buried in the same trench.

C. Remove all foreign matter or dirt from the inside of the pipe before joining. Cap or plug all lines after installation and prior to testing to minimize infiltration of foreign matter or dirt.

D. Snake pipe from side to side of trench bottom to allow for expansion and contraction. Install main lines and lateral lines in common trenches wherever possible.

3.2 WIRE INSTALLATION

A. Verify that the work of this section is installed in strict accordance with the latest edition of the National Electric Code and local electrical codes.

B. Install neutral and control wires, 12 inches below finish grade, in the same trenches as the main and lateral lines. The wires shall be installed in a neat and orderly fashion and bundled together and taped every 10 feet. Snake wires in trench to allow for expansion and contraction and provide slack loops at every splice, change of direction, at the valves, where the wire enters the conduit for the automatic controller and at least every 100 feet in runs more than 100 feet in length. The slack loops shall be created by wrapping 3 feet of wire around a 1/2 inch diameter pipe to form a coil.

C. Connect each solenoid to the controller with a "control wire" which is typically red in color. Connect a "common neutral wire" to all solenoids which is typically white in color.

D. Wire Splices must be properly insulated and waterproofed. Control wire splices will be allowed only in runs more than 500 feet and only in valve boxes.

3.3 CONTROLLER AND SENSOR INSTALLATION

A. Coordinate with the General Contractor the exact location where the automatic controller will be locat-ed. Connect all wiring and grounding in accordance with manufacturer's instructions. Provide separate, secured to the wall, conduits for both power supply and control wiring.

B. The General Contractor shall provide GFIC outlets with 115vac; 1phase power at the Controller and Backflow Preventer Enclosure locations, as shown on the drawings.

C. Install the rain and freeze sensors in an open area where the device is exposed to rain water but not sprinkler water. Mount away from overhanging objects that may interfere with rainfall. Connect wiring in accordance with manufacturer's instructions.

3.4 VALVE INSTALLATION

A. The remote control valves shall be installed in accordance with manufacturer's instructions. Valves shall be installed in Highline valve boxes or approved equal. Boxes shall be installed to a height that will not cause them to interfere with maintenance machinery and which is sufficient to prevent soil or mulch from washing into the box. Provide a 6-inch layer of washed gravel in the bottom of the valve box.
   1. Valves shall be set a minimum of two feet behind curbs.
   2. Valves shall not be set in curves which are vulnerable to damage by truck trailers over running curbs.

B. The quick coupling valves shall be installed on PVC threaded swing joints on the irrigation mainline. Space quick coupling valves as shown on the plans. Provide a 1"x1"x3' piece of angle iron next to the quick coupling valve and anchor with two (2) stainless steel hose clamps.

C. The automatic drain valves shall be installed in the low points of the lateral lines. Dig a minimum two (2) cubic foot hole where the drain valve is to be located. Install the drain valve in a PVC tee pointing downward at a 45 degree angle. Surround the drain valve with a minimum one (1) cubic foot of gravel. Place an 18"x18" piece of weed cloth or burlap on top of the gravel. Finish to grade with top soil.

D. Install in the low points of the mainline, manual gate valves as needed for draining. Install 24" off of the mainline in Highline 10" valve boxes or approved equal.

3.5 DRIP SYSTEM INSTALLATION

A. Drip Control Zone Kit. Install Drip Control Zone Kit level and below grade with a minimum of 4 inches clearance to the top and sides of the inside of a rectangular valve box. Place a minimum of 6 inches of gravel in the bottom of the valve box.

B. Landscape Dripline (Inline Emitter Tubing). Landscape bed areas shall be sup-plied with rigid PVC lateral piping. Landscape Dripline connection points shall be made in 6 inch valve boxes using compression adapter tees or ells as required. For under mulch installation, place tubing rows at 18 inch lateral spacing as indicated on the plans and hold in place with galvanized tie-down stakes spaced evenly every 2 to 3 feet, and with two staples on each change of direction. Install tubing in a serpentine manner and

bending is allowed provided the radius is sufficient enough that kinking does not occur. Backfill with mulch as noted in the landscaping specifications.

C. Landscape Dripline Compression Fittings. Landscape Dripline Compression Fit-tings shall be used at connection points to the PVC lateral piping, where tubing layout requires a tee and at bends or changes of direction to prevent kinking of the Landscape Dripline.
   1. Removable flush caps shall be installed at the low point of each dripline section. Depending on the site conditions and tubing layout, more than one flush cap may be required. Provide a 6 inch valve box for each flush cap.
   2. Air/vacuum relief valves shall be installed at the highest elevation within each dripline section. Depending on the site conditions and tubing layout, more than one air/vacuum relief valve may be required. Provide a 6-inch valve box for each air/vacuum relief valve.
   3. Install a visual pop-up indicator For Each Drip Zone in an inconspicuous location. Note locations of indicators on As-Built drawings.

3.6 MAINTENANCE AND COMPLETION OF THE WORK

A. The Contractor shall complete the irrigation system as drawn and specified, according to Schedule herein, and operate and maintain same until time of substantial completion of the project.

B. The Contractor shall orient the Owner's personnel to the operation and adjustments of the controller according to local seasonal requirements. The Contractor shall also familiarize the Owner with sprinkler and valve adjustments. The Owner is, in general, to be totally familiarized with the overall operation, adjustment, maintenance and intent of the irrigation system, including the measures that should be taken to provide winterization for the system. Such instructions should be in written form. The contractor shall also provide a color coded laminated plan, in the controller door, showing the locations of all zones.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work, as required to make a complete and thorough preparation of the planting soil, including soil amendment products, imported topsoil, as required, to make up deficiencies in quantity of soil available on site, as shown in the Contract Drawings, and as specified herein this Section.

B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following:
   1. Agronomic Soil Fertility Testing and Soil Percolation Testing.
   2. Topsoil.
   3. Pre-Plant Weed Control.
   4. Soil Conditioners, Amendments and Fertilizers (Organic & Chemical).

C. Related Requirements:
   1. Section 31 2000:"Earthwork"
   2. Section 32 9300 "Plants" for placing planting soil for plantings.
   3. Section 32 8400: "Planting Irrigation"
   4. Section 32 9200 "Turf and Grasses" for placing planting soil for turf and grasses.

1.2 QUALITY ASSURANCE

A. Installer Qualifications for requirements indicated herein this Section:
   1. Licensed Landscape Contractor, in the State of Arkansas.
      a. Engage an experienced, licensed Contractor who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
      b. Installer's Field Supervision: Contractor shall maintain an experienced, full-time landscape supervisor/superintendent at the Project Site during times that landscaping operations identified herein the Contract are in progress.

B. Manufacturer’s Directions: Follow Manufacturer’s directions and drawings in cases where the Manufacturers of articles used in this Section furnish directions covering points not shown in the Contract Drawings or Contract Specifications.

C. Permits, Fees, Bonds, Testing, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, testing, and inspections necessary to perform and complete his portion of the Work.

D. Approved Testing Laboratory and Procedures for Agronomic Soil Fertility Analyses:
   1. Agronomic Soil Fertility Analyses shall be conducted by a reputable, certified, agronomic soils laboratory. Laboratory shall be a member of the Council on Soil

Testing and Plant Analysis. The same laboratory shall be used throughout the duration of the Contract:

2. Contractor shall verify and confirm the selected Testing Laboratory and specific location(s) of soil sample(s) with the Landscape Architect prior to commencing soil sampling operations.
3. For each Soil type, submit the physical Soil Samples directly to the selected Laboratory for analysis, per the procedures outlined per Part III herein this Section.
   a. In addition to the physical Soil Samples, Contractor shall also provide the Laboratory with a copy of the Soil Amendment and Fertilizer products indicated herein this Section.
4. Along with the testing data results, the Agronomic Soil Fertility Analysis shall also include written recommendations authored by the Laboratory conducting the Analyses for amending, treating, and/or correcting the sampled soils. Laboratory shall utilize the organic-based Soil Amendments and Fertilizers described herein this Section to the greatest extent possible to produce satisfactory planting soil(s) suitable for sustaining healthy viable plant growth.
   a. The Analyses shall also include Maintenance and Post-Maintenance fertilization programs for planted areas within the Contract.
5. Agronomic Soil Fertility Analyses shall be performed on each Soil Type samples, and include testing results for the following
   a. pH

      1) Electro-conductivity (salinity) measurement - saturated extract
      2) Measurement of sodicity (Sodium Absorption Ratio)
      3) Estimate of soil texture and soil organic matter
      4) Presence of lime
      5) Nutrients/Toxic Elements measurement of DPTA extract
      6) Saturation extracts for nitrate, sulfate, sodium, calcium, magnesium, potassium, soluble phosphate, and boron
      7) Parasitic nematodes
      8) Herbicide contamination
      9) (For Lightweight Soil Mixes): Test for physical and chemical composition, and saturated weight per cu.ft.
6. Planting operations shall not commence until the results of the Agronomic Soil Fertility Analysis and Recommendations are reviewed accordingly by the Landscape Architect.
7. The quantity or type of amendments may be modified by the Landscape Architect within fourteen (14) days of receipt of the results. The Agronomic Soil Fertility Analysis and Recommendations shall take precedence over the amendment and fertilizer application rates specified herein or on the Contract Documents.
8. The Agronomic Soil Fertility Report/Recommendation shall take precedence over the amendment and fertilizer application rates specified herein or on the Contract Documents.

1.3 CHEMICAL SOIL AMENDMENT COMPONENTS

A. General: Chemical Soil Amendment Components listed herein may or may not be used, depending on the results of the Agronomic Soil Fertility Report. Provide as required.

B. Gypsum: Commercially-processed and packaged agricultural-grade hydrated calcium sulfate product (CaSO4), 92.0% minimum, pH at 7.1.
   1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
      a. Ben Franklin® No. 1 Agricultural Gypsum, U.S. Gypsum Company.
      b. 100% Good Stuff Gypsum™, Art Wilson Company.
      c. CAL-SUL® Pelletized Agricultural Gypsum, North Pacific Group.
      d. Bumper Harvest Agricultural Gypsum, Domtar Gypsum.
      e. Premium 97 Solution-Grade Gypsum, Diamond K, Inc.
      f. Or equal, as approved by the Landscape Architect.

C. Soil Sulfur: Elemental Sulfur (90% min.) commercially manufactured, water degradable, palletized.
   1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
      a. Disper-Sul, Martin Resources, Inc.
      b. Soil Sulfur, Red Top.
      c. Or equal, as approved by the Landscape Architect.

D. Iron: Non-staining, 40% Fe minimum, complete with micro-nutrients and 2% humic acids, as derived from iron oxide, manganese oxide, or zinc oxide.
   1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the follo
      a. Gro-Power Iron, Gro-Power, Chino, CA.
      b. Iron 45 w/ Micronutrients, Tri-C Enterprises LLC, Chino, CA.
      c. Or equal, as approved by the Landscape Architect.

E. Dolomite Lime: Agricultural-grade mineral soil conditioner containing 35% minimum magnesium carbonate, and 49% minimum calcium carbonate, 100% passing #65 sieve.

F. Potassium Sulfate (Sulfate of Potash K2O), (0-0-50 guaranteed analysis N-P2O5-K2O): Agricultural-grade, containing minimum 50% of water-soluble potash and 18% Sulfur (S).

G. Single Superphosphate P2O5 (0-15-0 guaranteed analysis N-P2O5-K2O): Commercial product, containing 15% available phosphoric acid and 14% Sulfur.

H. Triple Superphosphate P2O5, (0-45-0 guaranteed analysis N-P2O5-K2O): Commercial product, containing 45% available phosphate and 15% Calcium (Ca).

I. Ammonium Sulfate (NH4)2SO4, (21-0-0 guaranteed analysis N-P2O5-K2O): Commercial product containing approximately 21% ammonia.

J. Ammonium Nitrate NH4NO3, (34-0-0 guaranteed analysis N-P2O5-K2O): Commercial product containing approximately 34% ammonia.

K. Calcium Nitrate CaNO3, (15.5-0-0 guaranteed analysis N-P2O5-K2O): Agricultural grade containing 15-1/2% nitrogen.

L. Potassium Nitrate KNO3, (13-0-45 guaranteed analysis N-P2O5-K2O): Commercial

product containing approximately 13% nitrogen and 45% potassium.

M. Ureaformaldehyde (38-0-0 guaranteed analysis N-P2O5-K2O): Granular commercial product containing approximately 38% nitrogen.

N. Urea CO(NH2)2, (46-0-0 guaranteed analysis N-P2O5-K2O): Granular commercial product containing 46% nitrogen

O. I.B.D.U. (Iso Butyldiene Diurea): Commercial product containing 31% nitrogen.

1.4 ACCESSORIES

A. Drain Rock/Aggregate: Crushed Stone, conforming to ASTM C33, graded to ¾"-size, clean, hard, durable, free of materials toxic to plant growth, set in bottom of Planters, at depth indicated in Contract Drawings. Provide Geotextile Filter Fabric between Drain Rock/Aggregate and amended planting backfill soil.

B. Wetting Agent/Water Storing Polymer: Non-biodegradable, granular, polyacrylamide polymer soil amendment.
   1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, approved through submittal.

C. Landscape Mulch Material:
   1. Organic Wood Mulch: Triple Hammered Hardwood Mulch
   2. Decomposed Granite: as specified on plans
   3. Landscape Mulch Material for Submersible Planting Pots: Native River Cobble, to be approved through submittal.

PART 2 - EXECUTION

2.1 APPLICATION RATES

A. Fertilizer Tablets shall be spread equidistantly around the perimeter within the Amended Planting Backfill Mixture, up to within three-inches (3") of the finished grade of the Mixture, and at the following rates:
   1. Size of Plant Material - One (1) gallon Container stock; Total Quantity of 7-gram tablets - One (1) Tablet
   2. Size of Plant Material - Five (5) gallon Container stock; Total Quantity of 7-gram tablets - Six (6) Tablets
   3. Size of Plant Material - Fifteen (15) gallon Container stock; Total Quantity of 7-gram tablets - Ten (10) Tablets
   4. Size of Plant Material - 2.5" Caliper Stock; Total Quantity of 7-gram tablets - Fifteen (15) Tablets
   5. Size of Plant Material - 3"-4" Caliper Stock; Total Quantity of 7-gram tablets - Twenty-two (22) Tablets
   6. Size of Plant Material - 5"-8" Caliper Stock; Total Quantity of 7-gram tablets - Thirty (30) Tablets
   7. Contractor shall not provide Fertilizer Tablets for designated native plant species, if directed by the Landscape Architect. Contractor shall verify with the Landscape

Architect, in writing, as to which plants are subject to not receive the Fertilizer Tablets.

B. Mycorrhizal Inoculum Application Rate:
   1. During application of Fertilizer/Planting Tablets, Mycorrhizal Inoculum shall be spread equidistantly around the perimeter within the Amended Planting Backfill Mixture, up to within three (3") inches of the finished grade of the Mixture, at the prescribed application rate per the Manufacturer's written recommendations.

2.2 MAINTENANCE

A. Protect graded areas from traffic and erosion. Keep free of trash and debris. Repair and reestablish grades in settled, eroded, and damaged areas.

B. Where completed areas are disturbed by construction operations or adverse weather, scarify surface, reshape, and compact to required density.

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. Provide sodded lawns as shown and specified. The work includes:
   1. Soil Preparation
   2. Sodding lawns and other indicated areas.
   3. Maintenance.

1.2 QUALITY ASSURANCE

A. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials.

B. Provide and pay for materials testing. Testing agency shall be acceptable to the Architect. Provide the following data:
   1. Test representative materials samples proposed for use.
   2. Topsoil:
      a. pH factor.
      b. Mechanical analysis.
      c. Percentage of organic content.
      d. Recommendations of type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

1.3 INFORMATIONAL SUBMITTALS

A. Submit sod growers certification of grass species. Identify source location.

B. Submit the following materials certification:
   1. Fertilizer(s) analysis.

C. Submit materials test report.

D. Upon sodded lawn acceptance, submit written maintenance instructions recommending procedures for maintenance of sodded lawns.

1.4 FIELD CONDITIONS

A. Work notification: Notify Architect at least 7 working days prior to start of sodding operations.

B. Protect existing utilities, paving, and other facilities from damage caused by sodding operations.

C. Perform sodding work only after planting and other work affecting ground surface has been completed.

D. Restrict traffic from lawn areas until grass is established. Erect signs and barriers as required.

E. Provide hoses and lawn watering equipment as required.

1.5 WARRANTY

A. Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until final acceptance. Re sod areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by the Landscape Architect.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sodding:
   1. Lay sod per plans to form a solid mass with tightly-fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains, and seeded areas.
   2. Do not lay dormant sod or install sod on saturated or frozen soil.
   3. Install initial row of sod in a straight line, beginning at bottom of slopes, perpendicular to direction of the sloped area. Place subsequent rows parallel to and lightly against previously installed row.
   4. Peg sod on slopes greater than 3 to 1 to prevent slippage at a rate of 2 stakes per yd. of sod.
   5. Water sod thoroughly with a fine spray immediately after laying.
   6. Roll with light lawn roller to ensure contact with sub-grade.

B. Sod indicated areas within contract limits and areas adjoining contract limits disturbed as a result of construction operations.

3.2 MAINTENANCE

A. Maintain sodded lawn areas, including watering, spot weeding, mowing, application of herbicides, fungicides, insecticides and resodding until a full, uniform stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Architect at the completion and acceptance of the entire project.
   1. Water sod thoroughly every 2 to 3 days, or as required to establish proper rooting.
   2. Repair, rework, and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.
   3. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" height. Repeat mowing as required to maintain specified height. Not more than 40% of grass leaf shall be removed at any single mowing.
   4. Apply Type B fertilizer to lawns approximately 30 days after sodding at a rate equal to 2.0 lbs. of actual nitrogen per 1,000 sq. ft. (140 lbs./acre). Apply with a mechanical rotary or drop type distributor. Thoroughly water into soil. *Only as required per soil test for Buffalo Sod

5. Apply herbicides as required to control weed growth or undesirable grass species.
6. Apply fungicides and insecticides as required to control diseases and insects

END OF SECTION

PART 1 -GENERAL

1.1 SUMMARY

A. Work Included: Provide trees, shrubs, ground covers, native perennials, native grasses and native wildflower and grass seed as shown and specified.
   1. Soil preparation.
   2. Trees, shrubs, groundcovers, native perennials and native grasses.
   3. Planting mixes.
   4. Mulch and planting accessories.
   5. Maintenance and Extended Management.

B. Related Requirements:
   1. Section 015713: Temporary Erosion and Sediment Control
   2. Section 328400 "Planting Irrigation" for complete irrigation systems.
   3. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
   4. Section 312100: Finish Grading
   5. Section 329400: Soil Preparation

C. Definitions:
   1. Plant Material(s) – Refers to living plant species, inclusive of trees, shrubs, groundcovers, vines, ornamental grasses, cacti/succulents, espaliers, annuals, perennials, etc., as indicated in the Contract Drawings.
   2. Planting Area (PA) – As denoted on the Contract Drawings, shall refer to areas to be installed with Plant Material(s), or areas where existing vegetation shall be protected.
   3. Plant Height – Measurement of main body height, not measurement to branch tip.
   4. Plant Spread – Measurement of main body diameter, not measurement from branch tip to branch tip.
   5. Amended Planting Backfill Mixture – Refer to Section 32 91 13 – Soil Preparation.
   6. Balled and Burlapped Stock – Healthy, vigorous exterior plants with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.
   7. Balled and Potted Stock – Healthy, vigorous exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.
   8. Bare-Root Stock – Healthy, vigorous exterior plants grown with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of exterior plant required.
   9. Compacted Settling Layer – Subgrade under where a plant is directly planted.
   10. Container-Grown Stock – Healthy, vigorous, well-rooted exterior plants grown in a

container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.

11. Fabric Bag-Grown Stock – Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.
12. Finish Grade – Elevation of finished surface of planting soil.
13. Manufactured Topsoil – Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
14. Multi-Stem – Where three (3) or more main stems arise from the ground from a single root crown or at a point right above the root crown.
15. Sub-grade – Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
16. Subsoil – All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Requirement: Valid Arkansas Landscaping Contractor License.
   2. Engage an experienced Installer who has demonstrated completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
   3. Installer's Field Supervision Installer shall maintain an experienced full-time supervisor on the Project site during times that landscaping installations under this Section are in progress.
   4. Selections of Plant Material may be sourced and purchased by the Owner directly. Contractor to provide a line item installation cost and separate warranty identifying the schedule of values for each.

B. Plant Material:
   1. Trees, Shrubs, Grasses and Seed: Provide quality, size, genus, species, and variety of Plant Material indicated, complying with applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock."
      a. At least one (1) plant of each Plant Material species delivered to the Project Site shall have an identification tag from supplying nursery showing botanical and common name of the plant as identified in the Contract Drawings. Landscape Architect shall be provided the opportunity for an on-site debriefing by the Contractor that identifies the size and specific type of Plant Material upon delivery.

         1) Incorrect Planting Materials

            a) Provide replacements equal to the size and quality to match the planted materials at the time the untrue species is discovered.

      b. Replace, at no cost to Owner, Plant Material that is revealed during the

course of the Contract as to being untrue to the species indicated in the Contract Drawings and reviewed accordingly under this Section.

2. Native Wildflower and Grass seed: Provide quality seed and/or custom mix identified within the Construction Documents. Noxious weed seeds shall not exceed one-half (1/2) percent by weight of the total of pure live seed and other material in the mixture. Johnson Grass, nutgrass or other noxious weed seed will not be allowed.
   a. At least one-half (1/2) pound of each seed/seed mix species delivered to the Project Site shall have an identification tag from supplying nursery showing botanical and common name of the plant as identified in the Contract Drawings. Landscape Architect shall be provided the opportunity for an on-site debriefing by the Contractor to verify the species of seed upon delivery.
   b. Incorrect Seed Materials:
      1) Replace, at no cost to Owner, Seed that is revealed during the course of the Contract as to being untrue to the species indicated in the Contract Drawings and reviewed accordingly under this Section.
      2) Provide replacement seed at the time the untrue species is discovered.
   c. Replacement of Plant Material: Refer to the Guarantee Article indicated herein this Section

C. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

D. Regulatory Requirements:
   1. Contractor shall meet the requirements of applicable laws, codes, and regulations as required by the authorities having jurisdiction over the Work. Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

E. Permits, Fees, Bonds, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, and inspections necessary to perform and complete Work under this Section.

F. Plant Material Review and Selection (Tagging):
   1. At the discretion of the Landscape Architect, Plant Material will be subject to review, photographed, and selected/tagged by the Landscape Architect at the nursery, or other place of growth, prior to delivery to the Project Site. Contractor shall verify with the Landscape Architect if tagging operations are required.
   2. Selecting/Tagging of Plant Materials at the nursery or place of growth does not cancel the right of the Landscape Architect to reject Plant Materials at the Project Site, if damaged or unacceptable conditions are found that were not detected at the nursery, place of growth, or in the submitted photographs.

G. Plant Material Delivery: Plant Material shall be delivered with original Plant Material tagging materials set in place, as selected, and marked by the Landscape Architect at the nursery or place of growth. Seed, topdressing, and any fertilizer materials shall be delivered in original containers. Include materials showing weight, analysis, and names of growers. Store all seed material in a manner to prevent wetting, excessive heating, or other deterioration. Contractor shall notify Landscape Architect upon delivery of Plant Material for review of stock and tagging materials. Plant Materials delivered without original tagging materials, or with broken, damaged, or altered tagging materials, shall be subject to rejection by the Landscape Architect. Rejected Plant Material shall be removed immediately.

H. Pre-installation Conference: Conduct conference at Project Site.

I. Protection of Existing Plant Material:
   1. Refer to Requirements specified in Section 015639 – Temporary Tree and Plant Protection.
   2. It is the intent of the Contract Documents that certain existing Plant Materials shall be retained. Prior to the removal of any Plant Materials, the Contractor shall confer with the Landscape Architect to determine which Plant Materials are to remain.
   3. All existing Plant Materials which are to remain in the project shall be tagged and identified by the Contractor prior to start of Work.
   4. Contractor shall be responsible for Plant Materials that are designated to remain. Damage to any Plant Materials which results in death or permanent disfiguration of said Materials shall result in compensation outlined in Section 01 56 39 – Temporary Tree and Plant Protection. The Landscape Architect shall be the sole judge of the condition of the Plant Materials.
   5. Existing Plant Materials designated to remain shall be protected at all times from damage by construction activity (tools, materials, equipment, personnel, etc.). Damage by the Contractor to existing Plant Materials shall be repaired at the Contractor's expense to the satisfaction of the Owner, as directed by the Landscape Architect.
   6. Contractor shall insure that no foreign material and/or liquid, such as paint, concrete, cement, oil, turpentine, acid or the like, be deposited or allowed to be deposited on soil within the drip line (the outside edge of the foliage overhang) of any Plant Material. Do not store construction materials, debris, or excavated material within drip line of existing Plant Material. Should any such poisoning of the soil occur, the Contractor shall thoroughly remove said soil as directed by the Landscape Architect and replace with acceptable soil at no additional cost to the owner.
   7. Excavation adjacent to existing Plant Materials: Where it is necessary to excavate in close proximity to the drip lines of existing Plant Materials, all possible caution shall be exercised to avoid injury to roots and trunk. Excavation close to Plant Materials shall be done by hand, with narrow-tine spading forks or other approved tools to comb soil to expose roots. Tunnel under roots two-inches (2") and larger in diameter. Cutting of roots two-inches (2") and larger shall be only on the approval of the Landscape Architect.
   8. Replacement of Damaged Plant Material: Replace existing Plant Material to remain as required, hat are damaged by Contractor during construction with accepted Plant Material of the same species, size, and quantity as those damaged, at no additional

cost to Owner. Owner shall be the sole judge as to the extent of the damage and the value of said damaged Plant Material.

1.3 FIELD CONDITIONS

A. Work notification: Notify Architect at least 7 working days prior to installation of plant material.

B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.

C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the draw¬ings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern.

1.4 WARRANTY

A. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of 1 year after completion and acceptance of entire project.
   1. A review of plants will be made by the Architect at Substantial Completion and Final Completion.

B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Architect, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes such as bark abrasions and misuse of chemicals, due to the Landscape Contractor's negligence. The cost of such replacement(s) is at Landscape Contractor's expense. Warrant all replacement plants for 1 year after installation.

C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting area, acts of vandalism or negligence on the part of the owner.

D. Remove and immediately replace all plants, as determined by the Architect, to be unsatisfactory during the initial planting installation.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. Immediately upon award of Contract for Work in this Section, Contractor shall locate and purchase or hold for purchase plant material as required.
   1. Contractor shall verify with Landscape Architect of Plant Material that has been nursery “contract grown” by the Owner for use of Work under this Contract.
   2. Contractor shall review the condition of the Plant Material with Landscape Architect at the nursery maintaining the Plant Material prior to delivery, and when delivered to the Project Site.

B. Quality: Plant Materials shall have a growth habit typical for each variety and species

indicated in the Plant List (as detailed on the Contract. Drawings).

1. All Plant Materials specified shall be superior/premium-grade nursery stock, full, densely foliated, symmetrical, with tightly knit branching, so trained or favored in development and appearance in form, number of branches, compactness and symmetry, healthy, and vigorous in growth, as reviewed and determined by the Landscape Architect
2. Plant Materials shall be free from insect pests, eggs and larvae, plant diseases, sun scalds, fresh bark abrasions, excessive abrasions, windburn, salt burn, weeds, or other disfigurements or conditions, as reviewed and determined by the Landscape Architect.
3. Plant Material shall be subject per the Arkansas State Department of Agriculture's Regulations for Nursery Inspections of Rules and Grading.
4. Growing Conditions: Plant Materials shall be nursery-grown in accordance with good horticultural practices under climatic conditions similar to those of project unless otherwise specifically authorized.

C. Container Stock (excluding annuals) shall be grown in boxes or containers in which delivered for at least one (1) growing season, but not over two (2) years. Plant Material grown in boxes or containers shall be cultivated during this time to permit full rooting within the specified box or container to bind the planting soil, but not so long as to create a "root-bound" condition.
   1. Plant Material shall be completely free of circling, kinked or girdling trunk surface and center roots, and show no evidence of a pot-bound condition.
   2. No boxed nor container Plant Material shall be planted which have cracked or broken balls of earth when separated from their boxes or containers.
   3. No Plant Material shall be planted with damaged roots, broken root balls, or which are found to be "root-bound" when separated from their containers.

D. Pruning:
   1. Do not prune Plant Materials unless directed by the Landscape Architect.
   2. Pruning of Plant Material as grown at the nursery shall conform to ANSI A300 Standards.
   3. Consult with Landscape Architect for pruning Plant Materials after delivery and installation.

E. Measurements: Measure Plant Material according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes.
   1. Take caliper measurement at a point on the trunk six-inches (6") above natural ground line for trees up to four-inches (4") in caliper (at a point twelve-inches (12") above the natural ground line for trees over four-inches (4") in caliper).
      a. Measure foliage across mean foliage dimension when branches are in their normal upright position.
      b. For trees to be supplied in "raised up" condition, foliage origin along main trunk shall be measured from soil line after installation.
      c. Height and spread dimensions specified refer to main body of plant and not branch tip to tip. Properly trimmed plants shall measure the same in any direction. If a plant is unevenly grown, it shall be classified in the size category of the smallest dimension.
   2. Size Range: If a range of size is given, do not use Plant Materials less than the

minimum size. The measurements specified are the minimum size acceptable and are the measurements after pruning, where pruning is required. Plant Materials that meet the measurements specified, but do not possess a normal balance between height and spread shall be rejected.

F. Field Dug Stock: Prior to digging of field-grown Plant Materials, ensure that excess loose fill resulting from cultivation around trunks/stems and over roots be removed down to natural finish grade at crown of Plant Materials. During digging, verify that size of tree spade or other equipment is adequate to encompass the actively growing root zone of all Plant Materials. Plant Materials which, after digging, show mostly large fleshy roots and few fibrous roots, will be rejected.

G. Condition of Root Systems: Plant Materials must prove to be completely free of circling, kinked or girdling trunk surface and center roots and show no evidence of a root-bound condition. Upon inspection by Landscape Architect at the job site, if five-percent (5%) or more of the plants of each species are found to contain kinked, circling or girdling roots, all plants of that species shall be rejected.

H. Unacceptable Trees: Trees that have damaged, broken, pruned, or crooked leaders will be rejected. Trees having a main leader shall not have been headed back. Trees with abrasions of the bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 3/4 in. which have not completely callused will be rejected.

2.2 ACCESSORIES

A. Reference – Section 32 94 00 Landscape Planting Accessories

PART 3 - EXECUTION

3.1 INSTALLATION

A. Plug Plant Material: Set Plug Plant Material plumb and in center of the excavated hole, with top of root structure set properly at the adjacent finish grade as indicated. Set Plug Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.
   1. Thoroughly soak the roots in clean water for a minimum of two (2) hours but no more than four (4) hours to fully hydrate the root mass. Do not soak above the root crown.
   2. Carefully place the Plant Material stock on the specified setting layer of compacted native soil, with the top of root mass set approximately one half-inch (1/2”) above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide an orientation of the Plant Material that is confirmed and acceptable by the Landscape Architect.
   3. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
      a. ¼ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
      b. ½ pound of Granular Soil Conditioning Material & Fertilizer (per Section

329113–Soil Preparation).

c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 329113 – Soil Preparation), per the Manufacturer's latest printed instructions.

1) Pending the results of the Agronomic Soil Fertility Report, the Amended Planting Backfill Mixture may be modified accordingly to include additional soil amendments or fertilizers (gypsum, iron, potash, etc.) or the ratios as indicated in the Mixture indicated above may be modified.

a) The cost of providing modifications to the Amended Planting Soil Backfill Mixture (as recommended through the Agronomic Soil Fertility Report and as directed by the Landscape Architect) shall be borne by the Contractor.

4. Backfilling the excavated planting hole:
   a. Place the Amended Planting Backfill Mixture around the Plant Material root mass in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets.
   b. Maintain the Plant Material plumb while working the Mixture around the root mass. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
   c. Add the Fertilizer Tablets and other amendments, (per Section 329113 – Soil Preparation) as required, at the prescribed application rates (as indicated per Section 329113 – Soil Preparation) or if not indicated, per the Manufacturer's latest printed instructions.
   d. Place the final layers of the Amended Planting Backfill Mixture, tamping accordingly, to the top of the root mass.
   e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole.
   f. Thoroughly mix together water and Plant Vitamin/Hormone Stimulant in application ratio as recommended by Stimulant Manufacture (per Section 329400 –Landscape Planting Accessories). Apply liquid matrix in sufficient quantity to thoroughly saturate the basin to settle the Mixture, and to eliminate voids and air pockets. Should any portions of the root mass be exposed, add additional Mixture as needed to thoroughly cover the root mass.
5. Mulching: Apply mulch evenly at 1" at all plug installation locations. Refer to Section 32 94 00) – Landscape Planting Accessories for type and requirements.

B. Balled and Burlapped Plant Material: Set the Balled and Burlapped Plant Material plumb and in center of the excavated hole, with top of the root ball raised above adjacent finish grade as indicated. Set Balled and Burlapped Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.
   1. Carefully place the Balled and Burlapped Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set two-inch (2") above the finished grade to allow for settlement of the Plant Material within the

excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation of the Plant Material, handle the Plant Material by its root ball; avoid handling the Plant Material by its trunk.

2. Once orientation is accepted, carefully remove the burlap and wire baskets from the tops of the root ball and partially from the sides, but do not remove from under the root ball. Do not damage the root ball or any part of the plant. Plant Material shall be rejected if the root ball is cracked or broken before or during the planting operation.
3. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
    a. ¼ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
    b. ½ pound of Granular Soil Conditioning Material & Fertilizer (per Section 32 91 13– Soil Preparation).
    c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 32 91 13 –Soil Preparation), per the Manufacturer's latest printed instructions.
4. Backfilling the excavated planting hole:
    a. Place the Amended Planting Backfill Mixture around the root ball in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets.
    b. Maintain the plant plumb while working the Mixture around the root ball. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
    c. Add the Fertilizer Tablets and other amendments, (per Section 32 91 13 – Soil Preparation) as required, at the prescribed application rates indicated herein this Article or if not indicated, per the Manufacturer's instructions.
    d. Place the final layers of the Mixture, tamping accordingly, to the top of the root ball. Do not place the Mixture on top of the root ball. Pull soil away and exposed root flare. Ensure root flare is planted above finished grade.
    e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole. Do not cover the top of the root ball with the backfill mixture.
    f. Thoroughly mix water and Plant Vitamin/Hormone Stimulant in application ratio as recommended by Stimulant Manufacture (per Section 32 94 00– Landscape Planting Accessories). Apply liquid matrix in sufficient quantity to thoroughly saturate the basin to settle the Mixture, and to eliminate voids and air pockets. Should any portions of the root mass be exposed, add additional Mixture as needed to thoroughly cover the root mass.
5. Mulching: Apply mulch in watering basins as indicated on the Contract Drawings. Refer to Section 32 94 00 – Landscape Planting Accessories for type and requirements.
6. Wrapping:
    a. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
    b. Wrap trunks of all trees as directed spirally from bottom to top with specified tree wrap and secure in place.

c. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
d. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.

7. Staking/guying:
   a. Stake/guy all trees immediately after each tree planting.
   b. Stake all trees and all multi-trunk trees.
   c. Flag or color all cables.
   d. All work shall be acceptable to the Landscape Architect.

C. Container-Grown and Ball and Burlap Plant Material: Set Plant Material plumb and in the center of the excavated planting hole, with top of the root ball raised above adjacent finish grade as indicated. Set Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.

1. For plastic container stock (4" pot, 1-gallon, 5-gallon, 15-gallon, etc.), carefully remove the plant container prior to setting the plant in the excavated hole so as not to damage root ball. Tip container to horizontal position and shake carefully to remove Plant Material. Support root ball during installation to prevent cracking or shedding of soil.
2. Set the Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set one-inch (1") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation of the plant material, carefully handle the Plant Material by its container; avoid handling the Plant Material by its trunk.
   a. Plant Material with a damaged root ball upon removal of the container, or if the root ball fails to thoroughly hold the soil as it is removed from the container, or if the plant is mishandled or damaged during planting operations, shall be rejected.
3. For Ball and Burlap stock, carefully set whole root ball of the Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set two-inch (2") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation, carefully handle the Plant Material by its basket; avoid handling the Plant Material by its trunk or branches. Once orientation is accepted, remove 1/3 of the wire basket so as not to damage the root ball or any part of the plant. Do not remove the bottom of the wire basket. Discard top 1/3, do not bend back or bury.
   a. Plant Material with a damaged root ball upon placing/planting, or if the root ball fails to thoroughly hold the soil as it is planted, or if the plant is mishandled or damaged during planting operations, shall be rejected.
4. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
   a. ¼ yard of Bulk Composted Organic Soil Amendment Material (per Section

32 91 13 – Soil Preparation).

b. ½ pound of Granular Soil Conditioning Material & Fertilizer (per Section 32 91 13– Soil Preparation).

c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 32 91 13 –Soil Preparation), per the Manufacturer's latest printed instructions.

1) Pending the results of the Agronomic Soil Fertility Report, the Amended Planting Backfill Mixture may be modified accordingly to include additional soil amendments or fertilizers (gypsum, iron, potash, etc.) or the ratios as indicated in the Mixture indicated above may be modified.

a) The cost of providing modifications to the Amended Planting Soil Backfill Mixture (as recommended through the Agronomic Soil Fertility Report and as directed by the Landscape Architect) shall be borne by the Contractor.

5. In areas where indicated on the Contract Drawings, install the Deep Watering Bubblers as part of the irrigation system.
6. Backfilling the excavated planting hole:
   a. Place the Amended Planting Backfill Mixture around the root ball in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets. Foot tamp the backfill, as required.
   b. Maintain the plant plumb while working the Mixture around the root ball. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
   c. Add the Fertilizer Tablets and other amendments (per Section 32 91 13 – Soil Preparation) as required, at the prescribed application rates indicated herein this Article or if not indicated, per the Manufacturer's instructions.
   d. Place the final layers of the Mixture, tamping accordingly, to the top of the root ball. Do not place the Mixture on top of the root ball.
   e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole. Do not cover the top of the root ball with the backfill mixture.
7. Mulching: Apply mulch in watering basins as indicated on the Contract Drawings. Refer to Section 32 94 00 – Landscape Planting Accessories for type and requirements.
8. Wrapping:
   a. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
   b. Wrap trunks of all trees as directed spirally from bottom to top with specified tree wrap and secure in place.
   c. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
   d. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.
9. Staking/guying:
   a. Stake/guy all trees immediately after each tree planting.

b. Stake all trees and all multi-trunk trees.
c. Flag or color all cables.
d. All work shall be acceptable to the Landscape Architect.

D. Native Wildflower and Grass Seed Material: Drill or hand apply seed per volumes specified within the Construction Documents. Apply native grass and wildflower seed after ground preparation is complete between September 15 and October 15 or February 15 and March 15. Landscape Architect shall be consulted prior to seeding to review preparation and installation.
1. Seed as follow to ensure complete coverage as noted:
a. Treat all seed areas with an aquatic approved herbicide when vegetation is present, two (2) prior to all seeding.
b. Fine grade areas that receive seed eliminate low areas that may hold water.
c. Provide 2 parts masonry sand to 1 part pure live seed (PLS). Granule Mycorrhizal shall also be included and may substitute the masonry sand.
d. Herbicide reapplication shall be required prior to broadcasting seed if visible vegetation is present.
e. Broadcast half the Native Grass and/or Wildflower Seeds evenly over the entire area prior to placement of compost at the rates indicated within the Construction Documents. Sow remaining seed in a perpendicular direction to the initial sowing prior to placement of compost.
f. Placement of one-half inch (1/2”) organic compost by Landscape Contractor
g. Wildflower seed to be broadcast similar to the above and seed shall be allows to rest on top of the compost without pressing into the substrate. Do not cover the seed more than 1/16”.
h. Cover seed with a 100% wood fiber hydroseeding mulch.
2. Jute netting or Biodegradable Erosion Control Blanket:
a. Install per plans and/or all areas that exceed 3:1 slopes using biodegradable stakes.

3.2 PLANT MAINTENANCE

A. Maintain the trees, shrubs, groundcovers, perennials, native grasses until Final Completion of the entire project. Upon Final Completion, the Owner will assume maintenance as recommended by the written maintenance instructions submitted by the Landscape Contractor for Sodded areas only.

B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.

C. Tighten and repair guy wires and stakes as required.

D. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.

E. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.

F. Deep-water trees, plants, groundcover, perennial and native grass beds within the first 24

hours of initial planting, and thereafter as required for healthy growth until final acceptance.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Piping joining materials.
2. Dielectric fittings.
3. Sleeves.
4. Identification devices.
5. Grout.
6. Piping system common requirements.
7. Concrete bases.
8. Metal supports and anchorages.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Dielectric fittings.
2. Identification devices.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch** maximum thickness, unless otherwise indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, **1/8 inch** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D2235.
2. CPVC Piping: ASTM F493.
3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
4. PVC to ABS Piping Transition: ASTM D3138.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

PART 3 - EXECUTION

3.1 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
1. NPS 2 (DN 50) and Smaller: Dielectric unions.
2. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
1. NPS 2 (DN 50) and Smaller: Dielectric couplings or dielectric nipples.
2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.

3.2 INSTALLATION OF PIPING

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at

right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas **2 inches** above finished floor level.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
      a. Pipe Sleeves: PVC. For pipes smaller than **NPS 6**.
      b. Steel Sheet Sleeves: For pipes **NPS 6** and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.3 INSTALLATION OF EQUIPMENT

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Modular precast concrete manhole and structures with tongue-and-groove joints, cover frame, covers, anchorage, and accessories. For junction box and inlet structure, and detention basin.
   2. Bedding and cover materials.

B. Related Sections:
   1. Section 31 2000 - Earthwork
   2. Section 03 1000 - Concrete Forms and Accessories.
   3. Section 03 2000 - Concrete Reinforcement.
   4. Section 03 3000 - Cast-in-Place Concrete:.

1.2 QUALITY ASSURANCE

A. Perform Work in accordance with the City of Bentonville's applicable standards requirements.

PART 2 - PRODUCTS

2.1 FRAME AND COVERS

A. Manufacturers:
   1. [**{PropertyRef(Id=d2d7ca08-4c6a-4fa1-a3d0-d5b3b6f4afc4)}**]
   2. [**Refer to Drawings for frame, grates, and covers required for each manhole and structure.**]
   3. <**Insert manufacturer's name**>

B. Product Description: Cast iron construction, machined flat bearing surface and as shown on the Drawings.

2.2 COMPONENTS

A. Manhole Steps: corrosion resistant, coated, and reinforced with steel per ASTM C-478. Steel reinforcing minimum 1/2" diameter. Formed integral with manhole and structure sections.

2.3 BEDDING AND COVER MATERIALS

A. Refer to Section 312116, Trenching.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Excavation and Backfill:
   1. Excavate for manholes and structures in accordance with Section 312000 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes and structures in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Place base pad, trowel top surface level.

C. Place manhole and structure sections plumb and level, trim to correct elevations, anchor to base pad.

D. Backfill excavations for manholes and structures in accordance with Section 312000.

E. Form and place manhole and structures cylinder plumb and level, to correct dimensions and elevations.

F. Cut and fit for pipe sections.

G. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel as indicated on Drawings.

H. Set cover frames and covers level without tipping, to correct elevations.

I. Coordinate with other sections of Work to provide correct size, shape, and location.

3.2 PRECAST CONCRETE MANHOLE AND STRUCTURE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 312000 and 312116 or on other support system shown on Drawings.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer’s plant.

G. Verify manholes and structures installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

I. Cut pipe to finish flush with interior of structure.

J. Shape inverts through manhole and structures as shown on Drawings.

3.3 FRAME AND COVER INSTALLATION

A. Set frames using mortar and pre-cast concrete rings. Install precast reinforced concrete rings. Lay precast concrete rings in full bed of mortar and completely fill joints.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test cast-in-place concrete in accordance with Section 033000.

C. Vertical Adjustment of Existing Manholes and Structures:
   1. Where required, adjust top elevation of existing manholes and structures to finished grades shown on Drawings.
   2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
   3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.
   4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 033000.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe and fittings for site water line including domestic water line and fire water line
2. Valves.
3. Hydrants.
4. Positive displacement meters.
5. Backflow preventers.
6. Underground pipe markers.
7. Precast concrete vault.
8. Bedding and cover materials.

B. Related Sections:
1. Section 31 2000 - Earthwork: Product and execution requirements for excavation and backfill required by this section.
2. Section 31 2116 - Trenching: Execution requirements for trenching required by this section.
3. Section 33 1100 – Water service connections: Connections for domestic water service 2 inches or smaller.
4. Section 33 1200 - Disinfection of Water Distribution: Disinfection of site service utility water piping.
5. Section 32 0523 – Concrete for Exterior Improvements: Concrete for thrust restraints.

1.2 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Central Arkansas Water's (CAW), City of Little Rock Fire Department's, and the Arkansas Department of Health's requirements.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

PART 2 - PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
1. [**American Darling**]

2. [**Approved Equal.**]
3. [**Mueller.**]
4. [**Smith Metropolitan.**]
5. <**Insert manufacturer's name**>

B. 2-1/2 inches and Smaller: Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression IPS ends, with control rod, post indicator, extension box and valve key.

C. 3 inches and Larger: AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged mechanical joint ends, control rod, post indicator, extension box and valve key.

2.2 BEDDING AND COVER MATERIALS

A. Bedding: As indicated on Drawings

B. Cover: As indicated on Drawings

C. Soil Backfill from Above Pipe to Finish Grade: As indicated on the Drawings

2.3 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 32 0523.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPE

A. Maintain separation of water main from sewer piping in accordance with Arkansas Department of Health requirements.

B. Install pipe to indicated elevation to within tolerance of 1 inch.

C. Install ductile iron piping and fittings to AWWA C600.

D. Route pipe in straight line as indicated.

E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

F. Install access fittings to permit disinfection of water system performed under Section 02516.

G. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

H. Establish elevations of buried piping with not less than 2.5ft of cover.

I. Install trace wire continuous buried 6 inches below finish grade, above pipe line; coordinate with Section 33 1100.

J. Backfill trench in accordance with Section 31 2116.

3.2 INSTALLATION – VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

3.3 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 33 1200.

3.4 FIELD QUALITY CONTROL

A. Perform pressure test on domestic site water distribution system in accordance with Central Arkansas Water standards.

B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe and fittings for domestic water service connections to buildings.
2. Corporation stop assembly.
3. Curb stop assembly.
4. Meter setting equipment.
5. Water meters.
6. Backflow preventers.
7. Underground pipe markers.
8. Precast concrete vault.
9. Bedding and cover materials.

B. Related Requirements:
1. Section 312000 – Earthwork
2. Section 31 2116 - Trenching.
3. Section 33 1000 – Site Water Distribution
4. Section 33 1200 - Disinfection of Water Distribution

1.2 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Central Arkansas Water, City of Little Rock Fire Department, and the Arkansas Department of Health's standards and requirements.

PART 2 - PRODUCTS

2.1 CORPORATION STOP ASSEMBLY

A. Furnish materials in accordance with Central Arkansas Water's standards.

B. Corporation Stops:
1. Brass or red brass alloy body conforming to ASTM B62.
2. Inlet end threaded for tapping according to AWWA C800.
3. Outlet end suitable for service pipe specified.

C. Service Saddles:
1. Double strap type, designed to hold pressures in excess pipe working pressure.

2.2 BEDDING AND COVER MATERIALS

A. Bedding: As indicated on Drawings

B. Cover: As indicated on Drawings

2.3 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 32 0523.

PART 3 - EXECUTION

3.1 INSTALLATION – CORPORATION STOP ASSEMBLY

A. Make connection for each different kind of water main using suitable materials, equipment and methods approved by the Architect/Engineer.

B. Provide service clamps for mains other than of cast iron or ductile iron mains.

C. Screw corporation stops directly into tapped and threaded iron main at 10 and 2 o'clock position on main's circumference; locate corporation stops at least 12 inches apart longitudinally and staggered.

D. For plastic pipe water mains, provide full support for service clamp for full circumference of pipe, with minimum 2 inches width of bearing area; exercise care against crushing or causing other damage to water mains at time of tapping or installing service clamp or corporation stop.

E. Use proper seals or other devices so no leaks are left in water mains at points of tapping; do not backfill and cover service connection until approved by the Engineer.

3.2 INSTALLATION – PIPE AND FITTINGS

A. Maintain separation of water main from sewer in accordance with Arkansas Department of Health requirements.

B. Route pipe in straight line.

C. Install pipe to allow for expansion and contraction without stressing pipe or joints.

D. Install access fittings to permit disinfection of water system performed under Section 02516.

E. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

F. Establish elevations of buried piping with not less than 2.5 ft of cover.

G. Install trace wire continuous, buried 12 inches below finish grade, above pipe line; coordinate with Section 33 1000.

H. Backfill trench in accordance with Section 31 2116.

3.3 INSTALLATION – WATER METERS

A. Install Work in accordance with Central Arkansas Water's standards.

3.4 INSTALLATION – BACKFLOW PREVENTERS

A. Install backflow preventer where indicated on the Contract Drawings and in accordance with manufacturer's instructions.

B. Comply with Central Arkansas Water's requirements and plumbing codes in regards to testing and installation requirements.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 33 1200.

3.6 FIELD QUALITY CONTROL

A. Perform pressure test on domestic site water distribution system in accordance with Central Arkansas Water's standards.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes disinfection of potable water distribution system and testing and reporting results.

B. Related Requirements:
   1. Section 33 1000 - Site Water Distribution Product and Execution requirements for installation, testing, of site domestic water distribution piping.

1.2 CLOSEOUT SUBMITTALS

A. Disinfection Report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
   4. Name of person collecting samples.
   5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
   6. Date and time of flushing start and completion.
   7. Disinfectant residual after flushing in ppm for each outlet tested.

B. Bacteriological Report:
   1. Date issued, project name, and testing laboratory name, address, and telephone number.
   2. Time and date of water sample collection.
   3. Name of person collecting samples.
   4. Test locations.
   5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
   6. Coliform bacteria test results for each outlet tested.
   7. Certify water conforms, or fails to conform, to bacterial standards of the Arkansas Department of Health.

C. Water Quality Certificate: Certify water conforms to quality standards of the Arkansas Department of Health and Central Arkansas Water, suitable for human consumption.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Central Arkansas Water's standards.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation in accordance with Central Arkansas Water's specifications.
2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.

B. Bacteriological Tests:
1. After final flushing and before pipeline is connected to existing system, or placed in service, two sets of acceptable water samples collected from the new water line and taken on consecutive days shall be submitted by the Contractor to the bacteriological laboratory at the Arkansas Department of Health in Little Rock, Arkansas.
2. Samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater per the American Public Health Association, AWWA, and Water Environment Association (latest edition and shall show the absence of coliform organisms.
3. If samples collected are positive, the disinfecting procedures and samples shall be repeated until two consecutive day samples are tested safe.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Storm drainage piping.
   2. Accessories.
   3. Underground pipe markers.
   4. Catch basins and plant area drains.

B. Related Sections:
   1. Section 31 2000 – Earthwork: Backfill and compaction for structures and storm piping.
   2. Section 31 2116 - Trenching: Execution requirements for trenching required by this section.
   3. Section 33 0513 - Manholes and Structures.
   4. Section 03 3000 - Cast-in-Place Concrete: Concrete type for catch basin base pad construction.

1.2 CLOSEOUT SUBMITTALS

A. Project Record Documents:
   1. Accurately record actual locations of pipe runs, connections, catch basins, structures, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with the City of Bentonville's applicable standards requirements.

PART 2 - PRODUCTS

2.1 ACCESSORIES

A. Filter Fabric: Non-biodegradable, non-woven, 6 oz minimum weight.

B. Grout: Specified in Section 033000.

C. Bedding: As indicated on the Drawings.

D. Cover: As indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.

B. Place pipe on bedding material as indicated on the Drawings.

C. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 10 feet.

D. Place bedding backfill around pipe as indicated on the Drawings.

E. Install trace wire continuous over top of pipe buried 12 inches below finish grade, above pipe line.

3.2 INSTALLATION - CATCH BASINS AND STRUCTURES

A. Perform work in accordance with Drawings.

B. Refer to Section 330513, Manholes and Structures.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

END OF SECTION